BELL TELEPHONE QUARTERLY

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MEETING AN EMERGENCY AT BIRMINGHAM, ALABAMA

CONFERENCE TELEPHONE SERVICE

WORLD'S TELEPHONE STATISTICS

ADVENTURES IN COMMUNICATION

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW Y

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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Meeting an Emergency at Birmingham, Alabama

Editor's Note:

In the April, 1934, issue of the BELL TELEPHONE QUARTERLY, the Chief Engineer of the Indiana Bell Telephone Company described the co-operative efforts that restored telephone service in record-breaking time after a destructive fire at Anderson, Indiana. In the following article, the Chief Engineer of the Southern Bell Telephone and Telegraph Company graphically recounts similar efforts in meeting the emergency caused by a fire at Birmingham, Alabama, on March 10, and gives a picture of the telephone problem involved that reveals the complexities of telephone service in a large city as well as the traditional spirit of Bell System people.

THE lull of a Saturday noon in Birmingham, Alabama, was disturbed by an alarm of fire, and a smudge of smoke at the front corner of one of the city's largest department stores was the center of concentration of the downtown fire companies responding to a routine alarm. Hours later, when the hose was finally rolled up by exhausted, red-eyed firemen, Birmingham had experienced its worst fire and March 10, 1934, had become a day of tragedy long to be remembered. Buildings in an area of half a block had been consumed or seriously damaged and the fate of the downtown district had hung in the balance while a March wind whipped hundred-foot flames over the surrounding buildings and carried burning embers over a wide area. Heroic effort finally prevailed, and the city rested easy late that night with the fire finally controlled.

Large fires can have small beginnings, and the trace of smoke which trickled up from under the first floor of the Loveman, Joseph & Loeb department store shortly after 12:30 gave little indication that more than a fire extinguisher would be needed to combat it. No one's imagination could foresee that within a few short hours all available fire apparatus in Birmingham and the surrounding cities would be fighting to save the city from the results of so small a blaze, the hospitals would be receiving injured firemen, and a large area of the city would be without telephone service.

Telephone service for Birmingham was provided from six central office locations. The downtown area has two central office buildings: Main, which was damaged by the fire, is located on Second Avenue and housed local manual office No. 4, the toll switchboard for the city, and special services such as information and assistance operators; while the new building, a half-dozen blocks away on Sixth Avenue, contains the toll terminal and line repeater equipment, together with two step-by-step dial offices, designated No. 3 and No. 7. Three of the remaining buildings house dial offices, while the fourth serves a small outlying community on a manual basis. Traffic to and from the nearby town of Bessemer is handled on an A–B toll basis, with the dial service operators ticketing calls outgoing from the Birmingham dial offices.

Fire Under the Store's Ground Floor

The Loveman, Joseph & Loeb department store covered one-fourth of a block, as shown by Figure 1, which indicates the damaged area with respect to the telephone building. The clerks were waiting on several thousand customers who had responded to a well-advertised sale. Steel mill operations around Birmingham had picked up, coal mining had increased due to abnormally cold weather, and business was good. When smoke was seen and an alarm turned in, the management, in the exercise of conservative good judgment, proceeded to clear the store of all clerks and customers. Good feeling prevailed and everyone moved out casually for the few minutes needed for the firemen to handle a seemingly small job.

The four fire companies which normally respond to downtown alarms came up within a few minutes and proceeded toward the heart of the smoke. The store had a relatively small basement, in which the building services were located. The remainder of the first floor was from three to six feet above ground, with the floor supported on brick partitions which divided the area longitudinally into a number of restricted sec-

tions, each about 10 feet wide. The fire was located in one of these sections, which firemen found full of suffocating smoke, preventing direct entry. There was no sprinkler equipment in this space.

Recognizing that the first requirement of fighting a fire is to get at it, squads of firemen started cutting through the wooden

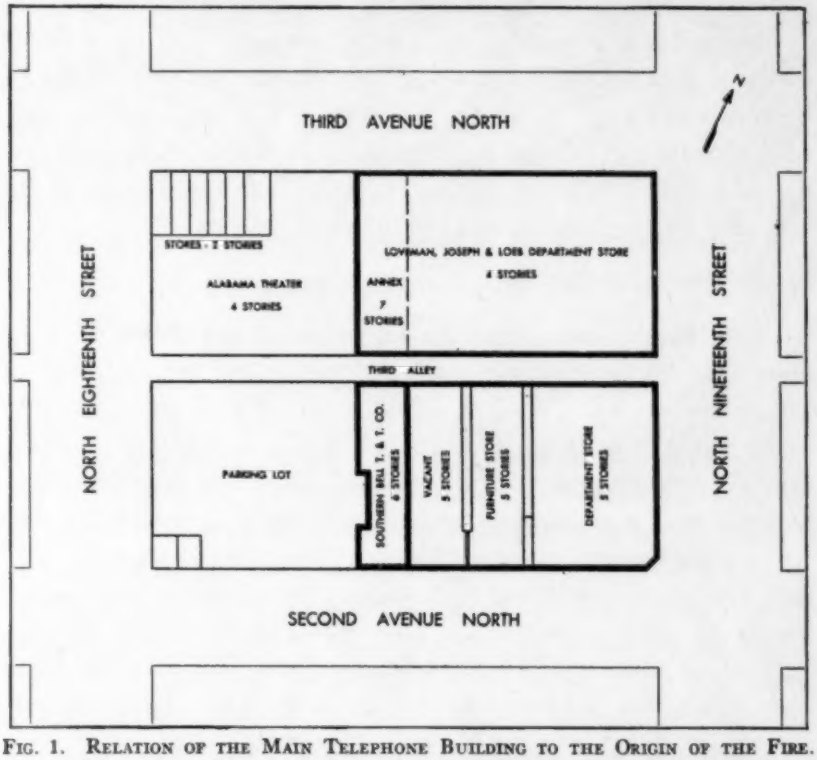


FIG. 1. RELATION OF THE MAIN TELEPHONE BUILDING TO THE ORIGIN OF THE FIRE. DAMAGED OR DESTROYED BUILDINGS ARE INDICATED BY HEAVY LINES

flooring of the first floor. By the time this was completed, a considerable blaze was burning in the area. Water introduced through these holes caused a reduction in the volume of smoke, and the firemen as well as the spectators thought the fight had been won.

This view was held but shortly, for an increased volume of smoke disclosed that the fire had spread over a much larger

area than had been anticipated and other sections under the first floor were burning. A second alarm brought up a number of additional fire companies and they continued the work of cutting through the floor at other points. The basement partitions greatly impeded the firemen, since each section presented a separate problem to be worked out while the fire spread rapidly from one to the other along the floor joists.

Smoke became unbearable to the firemen, and even relief every few minutes was not sufficient to permit operations to be continued from inside the building. The men were forced to withdraw and rely on flooding the first floor. A large quantity of smoke was then pouring from the building, but no flame was seen by the spectators until nearly 3:30 P.M.

The Building Was Doomed

Inflammable gases from the smouldering fire under the first floor went up the elevator shaft and stairs, and accumulated in the upper stories. With the first show of fire, the top three floors burst into flame with almost explosive violence. Upon this occurrence, no doubt remained that the building was doomed and a general alarm brought up the remaining fire crews with the exception of necessary reserve companies. Effort was then concentrated toward preventing the spread of flames to other structures. This was effective with the exception of those buildings directly across Third Alley from Loveman's, the majority of which were seriously damaged. Among the latter was the Main telephone building.

Part of the department store comprised a six-story reinforced concrete annex, which was directly to the rear of the telephone building and had openings on various floors into the main store building. This structure, being fire-resistive, fortunately offered a measure of protection to the telephone building.

Shortly after the fire started, the Alabama Plant Superintendent, together with other plant and traffic supervisory people, promptly proceeded to the telephone building, to be pres-

ent in the event any emergency should arise, remote as it seemed at that time. The fire, however, gave them little concern until after 1:30, when heavy clouds of smoke began pouring across Third Alley from Loveman's main building and annex, a stiff wind driving the smoke into the rear of the telephone building.

As soon as a possibility appeared that the fire might get out of control, vigorous measures were started toward protecting the service and saving the building and equipment. Maintenance of service as long as possible was an immediate concern, and all windows and doors at the rear of the building were latched and cracks around them caulked. Exhaust fans at the rear of each floor were operated to create a through draft from the relatively clearer air on Second Avenue at the front of the building. This gave a measure of relief to the operators on duty and those off for the afternoon who came without call with the knowledge that they would be needed to cope with the heavy traffic created by the emergency. The critical time which all telephone people dread, of discontinuing service from an office, was postponed.

Steps Taken to Protect the Equipment

Plant men and other employees off duty reported to the building, to assist with steps to protect the service and property. One squad manned the house fire line and saturated the roof in the face of blinding and suffocating smoke. All of the company's tarpaulins in the city were assembled at the building. Packing quilts and tarpaulins were secured from transfer companies and squads were assigned to cover the various equipment units for protection against possible water damage. Particularly noteworthy was the attention given to the main frame, since trunks between other offices passed through it and its loss would greatly complicate restoration if necessity arose for transferring the service to another location. This work was successful, and despite a great quantity of water later poured

into the upper portion of the building, the main frame remained undamaged.

The operators stuck grimly to their switchboards, for the growing fire was bringing a flood of telephone calls. It was children's day at the Alabama Theater, which adjoins the Loveman annex, and anxious mothers who heard the radio reports on the fire were calling to inquire about their children. Messages for doctors, ambulances, hospitals, piled in to add to the task. Long distance calls for help were made to cities in Alabama and Georgia—as far away as Atlanta—where fire-fighting equipment was dispatched or held in readiness.

Building Finally Had to Be Vacated

By this time great billows of smoke were rolling upward in black clouds from Loveman's, while flames leaped high into the air. Operators and plant employees could hear the roar of flames across the alley. Operators were working in relays of twenty minutes, and wet towels were given them to afford some relief to their smarting eyes as the smoke became more dense. The girls worked quietly and efficiently, although they could hardly see the switchboard markings. Plant men were stationed on each operating floor to assist them.

The Plant Superintendent was outside, for the purpose of giving the alarm should occupancy of the building become hazardous, and watched the hopeless battle of the firemen. The flames mounted in Loveman's main building and annex, whence the high March winds carried them across the twenty-foot alley against the buildings along Second Avenue.

At 3:30 the order was given to vacate the building, since the smoke and heat made longer occupancy impossible. The girls quietly arose from their positions and walked calmly to the street. No one ran and no one seemed excited; the same calm efficiency with which they handled the traffic marked their conduct at all times. Quarters were arranged for the operators

in a nearby hotel, so that the switchboard could be operated again promptly if the equipment escaped damage.

Some 8300 telephones were now without service. For a few, but very few, minutes Birmingham was isolated from telephone communication with the outside world. Soon after the toll switchboard was abandoned, however, operators were working in strange surroundings, operating the toll test board in the Sixth Avenue building to handle emergency calls.

Shortly after service was suspended in the Main building, discovery was made that the space between the ceiling of the sixth floor and the roof had ignited. The fire department responded and went into this attic space with three lines of hose. Smoke was thick in this restricted area and a number of firemen were overcome. Plant men who remained in the building to help carried out six of them to a first aid station set up by the American Red Cross in a nearby store. One of their own number was also overcome by smoke and had to be sent to the hospital.

Tons of Water Did the Damage

The telephone people watched with mixed emotions the immense quantity of water, usually their worst enemy, being poured into the building to save it from destruction by an even more dangerous one, knowing that telephone equipment which has been wet might almost as well have been burned. Despite the countless tons of water which went into this attic space, practically all but the largest roof timbers in the rear were destroyed and the ceiling gave way in several places on the sixth floor.

This was substantially all the fire damage. Wire glass doors and windows in the rear were cracked, but none gave way. Two ventilating fans were burned from their mountings, but the building did not catch fire from these openings. No equipment was hurt by fire, but upon the havoc wrought by water hangs the remainder of this narrative.

The General Office in Atlanta was notified promptly of the discontinuance of service, and by four o'clock the attic fire clearly indicated that substantial damage would be done to the equipment. Headquarters plant, traffic and engineering people needed were promptly assembled and plans made for the restoration of service on an emergency basis. Fortunately, there were two telephone buildings in downtown Birmingham, as noted above. Plans were formulated for the use of the new building when the probability arose that the equipment would have to be replaced.

The two dial units in this building had such margins, due to recession of station development, that sufficient line and switch capacity was available for the transfer of practically all lines served by the No. 4 Office. Comparative studies made some time ago had shown that the downtown area should ultimately be served from one center. It was obvious, therefore, that the proper method of emergency restoration was the employment of these available dial lines, with the thought that in the event the damage to the equipment proved to be as extensive as was at first apparent, the transfer could be made permanent.

Equipment Starts Rolling In

Provision of toll and special services presented a somewhat more difficult problem, and, various plans having been considered, decision was made to set up a temporary office in the assembly room of the Sixth Avenue building by modifying No. 550 private branch exchange sections, a quantity of which were available in Birmingham and at the Atlanta warehouse of the Western Electric Company. Movement toward Birmingham of these, together with switchboard cable, frame wire, dials, and station equipment was started at once, several trucks leaving Atlanta that night. The General Office Committee, having determined the basic plan of procedure, left Atlanta on the midnight train, arriving in Birmingham early Sunday morning.

By the time they arrived, the local forces had transferred all

PBX battery and ringing current feeders in the old office to the No. 3 and No. 7 building. Temporary trunks from each of these switchboards and all municipal, fire department, hospital, and doctors' residence telephones were connected to the dial office. Provision was thus made for public safety and imperative necessities.

Inspection of the old building and equipment found them to be saturated with water dripping from ceilings and still running down walls on all floors. Bowl type electric lighting fixtures as far down as the second floor were filled with water. Water in the walls formed blisters behind the paint even on the lower floors, and these still remained two months after the fire. Notwithstanding the efforts made to cover the equipment, water was standing in many switchboard sections and the cable runs were dripping wet. While the power switches were opened, current was fed into the equipment over the trunk circuits from other offices, which caused an electrolytic action to be set up resulting in the development of a foamy excrescence around certain of the terminal strips and on some of the cable runs. Relays and connecting blocks were green with corrosion. Efforts to dry out the switchboards, cable runs, and relays by application of heat and operation of fans were of no avail. The majority of the equipment clearly had seen its last service and it was evident that the transfer of lines to the dial office should be permanent.

Manpower Is Available When Needed

With the fact of permanency established, the problem of restoring service to the flat-rate telephones became largely a matter of cross-connecting lines on the old main frame from the subscribers' cables to available pairs in trunk cables to the dial office, and providing dials on the station equipment. Fourteen installers and six frame men were transferred to Birmingham from Nashville, Chattanooga, Memphis, and New Orleans to facilitate this work.

The assembly room in the Sixth Avenue building presented a spectacle of vigorous but orderly work. Plant men and Western Electric installers who had arrived in response to emergency calls were setting up the switchboard sections in three lines as they arrived by truck and express. The Outside Plant forces had run cables along the outside of the building and through windows, connecting a temporary distributing frame in the assembly room with the toll testroom on the third floor and the dial main distributing frame on the first floor. Battery and ringing current supply had been provided with twisted pairs from the power room.

PBX Circuits Modified

The No. 550 PBX was never intended to be used as a toll switchboard, having been designed to handle inter-communicating calls within a business house and calls to and from local dial or manual central offices. In the service in which the emergency placed this equipment, line terminals were connected to trunks from the dial offices, on the one hand, and, on the other, to toll lines through the intervening toll test board, carrier terminals, and repeaters. The relays and equipment at one end of a telephone circuit must be proper to function with those at the other. Signal lamps must be lighted to indicate incoming calls and extinguished when answered; dial switches must be operated by the switchboard dials, held until the conversation is completed, and released; and above all, conversations passing through the switchboard must be clear and without interruption. These problems, and countless others of a similar nature, necessitated the designing of the proper circuits for the PBX to operate with the circuits already installed in the dial offices and the toll terminal room. The problem was, in brief, somewhat similar to that of introducing a strange wheel into an old watch: much modifying had to be done.

Circuit design is normally a contemplative work, calling for studious concentration and, for best results, a relatively clois-

THE LOVEMAN, JOSEPH & LOEB BUILDING FIRE SHORTLY AFTER 3:30 P.M.

THE TEMPORARY TOLL OFFICE IN THE NEW DOWNTOWN BUILDING IN BIRMINGHAM, ALABAMA

tered seclusion. In this instance, uninterrupted concentration was a luxury denied under the pressure of arriving materials, installers looking for instructions as to procedure and, to cap all, an inexorable clock placing the minutes back of it until service should be restored. The job was there and traditional requirements fell. Circuits were developed on drawing boards, and from these pencil drawings equipment quantities were estimated, relays, keys and other items were ordered by telephone and immediately started moving toward Birmingham. When they arrived, wiring diagrams were ready and the installers, working almost shoulder to shoulder, placed the equipment in service. Despite the pressure, in no significant way was it necessary to change the circuits proposed, and each step toward the final result was an orderly procedure from the ground work of the previous one.

Long Distance Operation Under Difficulties

Birmingham is the most important long distance point in Alabama, and toll circuits converge thickly upon it from surrounding cities and towns. In all, 185 of these circuits were terminated on the toll switchboard, and the loss of this switchboard resulted in the loss to these towns of their principal, and in many cases only, outlet to the Bell System network. One of the first steps of service restoration was the establishing of an emergency toll circuit layout whereby terminal circuits at Birmingham were connected to give through connections. For example, an Atlanta-Birmingham circuit was connected with a Birmingham-Tuscaloosa circuit, resulting in a direct channel between Tuscaloosa and Atlanta, and consequently to the rest of the telephone world. This arrangement increased the need for circuits, and two carrier telephone systems which had been removed from service were reconnected. Thirty-four such inter-connections were made during Saturday night before the fire was extinguished, and later four more circuits were set up.

The operators who reported at the toll test room found a

strange switchboard. Nothing was familiar. Even the cords had two plugs on each end. Six operators took positions at the toll testboard and two at the telegraph board, to do the best they could with what they had. The American Telephone and Telegraph Company's test room force gave enthusiastic co-operation with that of the Southern Bell Company in instructing the operators and assisting them.

The testboard has no telephone signalling facilities for incoming calls, although the distant toll switchboards can be rung from it on outgoing calls. The emergency arrangement for traffic from cities where a large group of circuits was available, such as Atlanta, was to assign one circuit in each group for dispatching, with an operator at each end constantly connected to it. These operators would assign other circuits in the group to the regular toll operators as they were needed for messages. Telegraph test wires which run to other of the more important toll points were used for signalling on emergency calls. A Chicago operator with such a call, for example, would notify the testroom force there and they would use the test line to Birmingham to have the operator pick up the Chicago toll line which was being held. The Birmingham operator would then complete the call over emergency dial trunks which had been promptly installed, provided, of course, it was not for an Office 4 number. Distant exchanges without test wires were called frequently to see if they had Birmingham calls waiting. Eight testboard men stayed constantly with the operators to assist with this dispatching work, which was indispensable.

Method of Handling Long Distance Calls

Trunk equipment was not available for subscribers to reach the test boards, so hotels were notified and radio stations broadcast the information that emergency calls could be placed from the Sixth Avenue building, and booths with terminals on the testboards were installed for this purpose. Mr. Loveman, in whose building the fire started, was among the first to use

this equipment. Messenger service was provided to reach subscribers in the No. 4 office area who had incoming toll calls, and this arrangement was continued until the subscribers' local service had been restored.

During the fire there were a number of long distance calls from fire department officials to nearby towns in connection with additional fire apparatus. The radio studio of station WAPI was near the fire and was used by the fire department as a dispatching point. As is usual, the telephone company had furnished spare circuits to the studio in connection with chain broadcast arrangements which terminated on the test board, and these circuits permitted toll connections to be established to and from out-of-town points.

During Sunday, March 11, six sections of PBX equipment were placed in service for recording long distance calls and five as toll line positions, and these were used to supplement the testboard positions. During the day 333 calls were placed, about 50 per cent of a normal Sunday's business, and 88.6 per cent of the calls were completed. Three sections were arranged for information, operators at them distributing traffic to 12 operators at adjoining tables, where information records, fortunately saved from the Main building, were set up and placed in service at dawn on Monday.

Quick Restoration of Local Service

By Monday morning, 350 lines from Office 4 were being served from the dial unit. In addition to those demanded for public safety, other lines of more than average importance received the first emergency treatment. Since a large number of PBX switchboards, including those at hotels, were involved, about 3,600 telephones, or nearly 45 per cent of the total, had been restored to service within 36 hours.

A surplus of pairs existed in the trunk and tie cables between the Second and the Sixth Avenue buildings, and trunks between the manual and dial offices in these buildings no longer were

needed. Transfer of service could be effected by the installation of a 909-pair cable for about 2,400 feet between the Sixth Avenue building and a manhole near the old office. This cable was available in storage in Atlanta, New Orleans, and Louisville, and was ordered Sunday afternoon.

Monday morning the ducts in the conduit runs were rodded and pull-in wires placed. Everything was made ready so that when the cable arrived that afternoon by truck and express it was immediately pulled in place. This was completed shortly after midnight and on Tuesday all splices were made. It was placed in service as the pairs were needed.

All pay stations in the downtown area were served from the old office, and the dial units contained no equipment to which they could be connected. Facilities for operators to attend pay stations were installed in ten strategic locations in the downtown area, including the telephone company business offices and the railroad stations. This afforded substantial relief to the public station situation.

The Problem of Public Telephones

Emergency restoration of the remaining pay station service presented a particularly difficult problem. Six operator positions of suitable equipment would be needed to care for them, together with the measured service lines, on a manual basis, and tentative plans were made to secure these from available surpluses existing within the Southern Bell territory. Before work was started on this basis, a survey of pay station equipment in the outlying dial offices was made, disclosing that 400 lines could be served from them if it was found that they would operate over the long circuits to which they would be connected. In some instances, the wire resistances would be double the usual allowance for dial pulses to operate the selector switches. The possibility of differences in the ground potential between the pay stations and the outlying offices also cast a very dark shadow over the possibility of using this equipment,

since such potentials might interfere with the important function of collecting or returning coins.

Emergency situations demand emergency measures. Perhaps the pay stations could be made to work even under these almost absurdly abnormal conditions. Recording meters were connected in line circuits and records over 24 hours were taken of the ground potentials, which fortunately showed them to be small. Trial pay station equipment was set up at the stations which would have the highest resistance in the circuits to the offices and practical tests were made with a number of coins. Various classes of calls were dialed, and the connections were found to be properly made and coins were accurately collected or returned, even with the insertion of additional resistance in the circuits to assure that there were sufficient remaining margins to make the service reliable. This was sufficient proof, and the public pay stations and the more important semi-public ones were temporarily on this basis. An anomalous situation resulted from the pay stations in the heart of Birmingham bearing the recognizable office designation of telephones in the outlying town of Homewood.

The DSA Board Found Usable

Subsequent tests of the results of efforts to dry out the dial special service switchboard indicated that the replacement of certain cables would make these positions at least temporarily operative. This work was at once started and an addition of 600 answering jacks was made in it. Since the cable runs in the building could not be used, a 909-pair cable was extended from the main frame on the first floor up the outside of the building to the switchboard on the fourth floor. The remainder of the pay stations, together with all measured service, were transferred to this switchboard and service temporarily provided on a manual basis. The message rate lines were connected to terminals in dial office No. 3, so that incoming calls could be dialed directly to them. Dials were not installed

on these telephones and calls originating at them were automatically extended to an operator, who ticketed the calls and completed them over dial trunks. The pay station lines appeared individually in the DSA switchboard. Originating calls were set up by the operator over dial trunks to the several offices and the coins collected or returned. Incoming calls to the pay station group of numbers were extended to the operators, who completed the connections. Incidentally, the numbers selected for the pay stations operated from this switchboard were such that it will not be necessary to change them when the lines are transferred to the dial office.

The A–B toll traffic to Bessemer, which immediately after the fire had been handled by the small manual office No. 5, was transferred to the DSA switchboard.

The work of installing dials on the remainder of the flat rate telephones was proceeding at the rate of about 600 per day, and this work was completed by Tuesday, March 20. Ten days after the fire, all local service had thus been restored, the great majority of it on a permanent basis. A temporary directory was mimeographed, giving the new numbers of the Office 4 telephones, and this was distributed to telephone customers such as hotels, hospitals, public safety departments of the city, and important business houses. A permanent directory was issued on April 16.

Temporary Toll Switchboard Cut In

The toll switchboard work in the Sixth Avenue building went forward so rapidly that by the evening of Monday, March 12, 28 toll positions were in service. During the day 1,093 toll calls were placed, of which 76.1 per cent were completed. Additions were made on subsequent days until the temporary office comprised six recording positions, 27 toll line positions, and 11 positions of special services such as information and official business. Numerous tables were used in connection with intercept and information service.

The temporary toll switchboard initially was connected to line finder terminals in the same manner as subscribers' telephones for completing toll connections. This arrangement, provided as a matter of expediency, had a recognized deficiency in that the toll operator received no supervision of the connection, which necessitated that she listen in from time to time to ascertain the completion of the calls and any special requirements of the subscribers. As soon as the positions were made operative and service given, measures were taken to improve its quality. Among the first steps was the modification of the cord circuits to operate with standard trunk circuits to the dial offices to give the operators proper supervision of the calls. By Friday the 16th this was completed.

The toll service offered, while not quite up to the high levels of the System standards, was adequate and of sufficient quality to permit retention of temporary facilities until a new toll switchboard could be installed in an orderly manner and without large expenditures for overtime work. Transmission on some switched calls was not standard, but that between the more important points was adequately handled by direct circuits to offices other than Birmingham by the emergency toll layout. The jack space in the positions was not sufficient for all toll lines and local office trunks to appear together in front of all operators, so two special switching positions were provided with one appearance of each toll line in them with trunks from the other toll positions for establishing through connections. The inability to provide all toll lines together with trunks in front of each operator prevented giving toll service with the subscriber remaining on the line.

Toll Switchboard Shipped from Stock

While traffic was satisfactorily handled on these toll positions as an emergency matter, steps immediately were taken toward securing a new No. 3 type toll switchboard. The stock situation permitted the sections of this board to be shipped

promptly from the Western Electric Company plant in Kearny, N. J., and they began arriving by the time sufficient space, which had been used for offices on the fourth floor of the Sixth Avenue building, had been cleared of partitions. The switchboard sections were placed in their permanent location upon arrival. The detail engineering work was done in Kearny, by Western Electric and Southern Bell engineers, and the installers were able immediately to proceed with the installation of cabling and wiring. This was completed without overtime work and the switchboard placed in service on Saturday night, May 12, nine weeks after the fire.

This switchboard is the most modern type with the latest features. Key pulsing equipment is provided which automatically dials local numbers in response to operation of a set of 10 keys at each switchboard position, similar to those of an adding machine. Pad control equipment gives automatic adjustment of the transmission over the toll circuits and 26 repeaters or amplifiers were added to effect it. Electric calculagraphs are installed which record the time of toll connections to the second.

Men Rally to the Scene

The Western Electric Company was of inestimable assistance in the restoration work, with a total of 84 of its people reporting to Birmingham. Sixteen were from Chicago, ten from Cleveland, six from Pittsburgh, seven from Roanoke, and others from various scattered points. The District Superintendent of Installation in Pittsburgh had until recently been in charge of the Atlanta district, and was telephoned by a friend on the night of the fire that one of the cities in his old territory was ablaze and that he could hear the news from a radio station in Birmingham. He adjusted his radio set to that station just in time to hear the announcer say that the fire department now had three lines of hose into the telephone

building. Knowing what that meant, he arranged to catch the next train to Birmingham.

Installers began arriving on Sunday, and at once set to work helping the Southern Bell forces wherever needed. The Western Electric people, as well as those of the Southern Bell Company, were on the job day and night without rest. After the temporary arrangements had been completed, the new toll switchboard and equipment began arriving and they immediately started work on its installation. The provision of various desks and the addition of about 2,500 lines of equipment to the dial office will keep a large number of them in Birmingham until August.

All Operators Provided For

One hundred and twelve operators had been employed in the No. 4 manual office. Not one of these will lose employment because of the fire. Sixty of them were transferred to other Southern Bell exchanges where the increase in telephone service required the expansion of the forces, and arrangements were worked out whereby they were placed largely in the cities of their selection. The emergency created a need for a large number of operators for auxiliary services. The special service or "0" operator requirements were increased 160 per cent, information 140 per cent, and intercepting calls to Office No. 4 numbers necessitated 15 operators' positions. The great volume of record work required additional clerical help and operators were assigned temporarily to it. The rotary alphabetical files involved the correction of 6,000 listings in six files and intercept records entailed approximately 103,000 entries. Thousands of service orders had to be written for the transfer of telephones to the dial office. Bulletins listing frequently-called firms were prepared and later a complete record of the new numbers of the Office No. 4 subscribers was prepared and mimeographed for limited distribution. In addition, the new

directory which was rushed to press was given the usual care in checking and re-checking the listings.

Bad as the Birmingham situation was from a telephone viewpoint, it clearly could have been worse. The fire occurred after the peak of the toll business on Saturday morning, and by Monday the temporary toll office was operating, which minimized the effect on the toll service. The existence of the Sixth Avenue building, with spare dial facilities and space available for a new toll switchboard, greatly facilitated restoration of service. The toll test, telegraph, through line repeaters, and carrier equipment, being in this building, were, of course, undamaged, which resulted in uninterrupted service on the toll circuits through Birmingham and enabled the immediate connection of the temporary toll switchboard. The fact that the Office No. 4 main frame remained in good condition was another fortunate circumstance which permitted the ready transfer of lines to the dial units by the simple expedient of running cross-connections. Had it been damaged, the remaining offices in Birmingham would have been partially paralyzed, since trunks between them pass through this frame.

Local Co-operation and Approbation

The people of Birmingham were appreciative of the work of restoration and their warm approbation was encouraging and their co-operation was most helpful in the orderly restoration of service. The newspapers commented editorially on the effectiveness of the measures which were taken by the Company. The Birmingham *News* stated, in part:

" Birmingham cannot have failed to appreciate the remarkably fine job done by the Southern Bell Telephone and Telegraph Company in restoring service over the thousands of telephones that were put out of order by the big fire of March 10th, in which one of the Company's exchanges was destroyed.

" In an almost incredibly short time all the telephones were put back in service. The restoration was completed within little more than a week.

"Such a performance should not go unnoticed. The Company, its officials here and the workers here and from elsewhere who aided in it deserve the commendation and appreciation of the people of this community."

Despite their own tragedy and reconstruction problem, the Loveman, Joseph & Loeb Company took newspaper advertising space to say:

"Thanks! Telephone Company. Thanks for the old familiar number 7-3131—and thanks also for the speed with which our new switchboard was installed. Your employees are to be congratulated on the manner in which they brought order out of chaos."

F. M. CRAFT

NOTE: The author wishes to acknowledge the valuable assistance of Mr. Judson O'D. Shepherd, a member of the engineering organization of the Southern Bell Telephone and Telegraph Company, in the preparation of this article.

Conference Telephone Service

A LONG distance operator recently received a hurried call from a subscriber. "Operator," he said rather breathlessly, "I want to make six long distance calls and I have only twenty minutes to train time. Will you see how many of them you can rush through?"

"Would you care to speak with several of the parties at one time?" asked the operator.

"Why, why yes, I want to tell them all the same thing. But how—?"

"I will connect you with the conference operator."

A conference call to the six desired persons was completed, and the customer caught his train with time to spare.

This new conference service, which makes it practicable to talk by telephone with several people simultaneously, opens an additional field of usefulness to telephone service.

The history of telephony has been one of ever widening scope of service. The first telephone lines connected two stations only: usually a customer's place of business with his home, or a factory with the company's office. The establishment of telephone exchanges, the building of inter-exchange lines, and the extension of long distance service to a practically world-wide basis have progressively enlarged the possibilities of telephone communication. Until recently, however, telephone service generally contemplated conversation between two individuals only.

Now, various types of conference service are available, making possible simultaneous telephone communication among a group of people, thus affording an excellent new medium for the rapid interchange of ideas among a number of individuals or the dissemination of a personal message to a widely scattered group. Business men may discuss their problems at a round

table conference without leaving their desks, whether they are located in different offices in the same building, in different sections of the same city, or in several cities thousands of miles apart. Executives may easily keep personally in touch with their entire organizations, however large or far flung their enterprises may be. Families with children in school or with members in distant states may be united by telephone.

Foreseeing the wide range and variety of business and social uses of the telephone conference, the Bell System has developed several different forms of the service, designed to meet diverse requirements. These include private branch exchange conferences established on the customer's premises; local and long distance conferences established at the telephone central office; and conferences by means of the loud-speaker which makes a telephone conversation audible to a group.

Private Branch Exchange Conference Service

To provide for telephone conferences involving primarily people in the same business organization, arrangements are made at the customer's private branch exchange switchboard (or at the manual portion, in the case of a dial private branch exchange) to permit the attendant to interconnect several telephones. These arrangements consist primarily of special switchboard jacks giving access to a "grouping circuit." A conference connection is established by the attendant using her regular cords to connect the various telephones with this grouping circuit. The usual arrangements contemplate the interconnection of as many as five telephones, two of which may be reached over outside lines. Special arrangements may also be made to meet requirements involving a larger number of telephones.

Private branch exchange conference service has proved particularly valuable to business concerns with various departments located on different floors of a large building or in different buildings. They find that the telephone conference

avoids the time-consuming preliminaries of getting every one together in one place; and that, once the conference connection is set up, the conferees, being "busy," are less likely to be called away or interrupted than in a personal conference. Experience has also shown that it is easy to keep a telephone conference brief and to the point, particularly if one person acts as chairman, directing the discussion along previously planned lines and calling on individuals in turn for questions and comments.

Frequent use is made of the private branch exchange conference arrangements at the American Telephone and Telegraph Company's headquarters in handling inter-company as well as inter-departmental business. For instance, a Plant Engineering man, receiving a request for information or advice from some one in an Associated Company, may signal the private branch exchange attendant and ask that certain representatives of the Commercial and Traffic Divisions be put in on a conference connection. The attendant connects the incoming line and the three private branch exchange telephones to jacks of a conference circuit. Each person can then answer questions and contribute ideas on those phases of the problem in which he is particularly involved. The request is handled much more expeditiously and the subject covered more thoroughly than would be possible if the Plant Engineering man had to call each of the others separately, outline the problem, make note of answers to questions and comments, and then call the Associated Company man again and relay this information to him.

Many firms have set up regular routines for the use of telephone conference arrangements in carrying on their businesses. For instance, each of three executives of a certain brokerage house has two private branch exchange telephones with pick-up and hold keys, one for making and receiving routine calls and another, equipped with a lamp signal, for receiving urgent messages. An employee follows the news ticker and is in com-

munication with the floor of the Stock Exchange by private wire. When news or quotations of special interest come in, this employee signals the private branch exchange attendant and says "Flash." The attendant then connects the employee's line and the executives' special lines with the conference circuit and flashes the signal lamps. The executives come in on the conference circuit, hear the report and, if necessary, discuss the situation.

Local Exchange Conference Service

The telephone companies are now establishing, on demand, conference connections through telephone company switchboards, thus permitting several persons to talk together by means of regular telephone connections. This makes conference service available to other than private branch exchange customers, and also provides to private branch exchange customers a more extensive conference service than is feasible through their private branch exchange switchboards. Local conference service, for a maximum of ten or twelve parties, with satisfactory transmission between all telephones, may be provided by means of a bridging circuit. This equipment is usually installed at the toll switchboard, utilizing the high grade toll switching trunks for inter-office connections in order to maintain satisfactory transmission.

All conference calls are handled by operators specially trained for this service. To obtain either a local or a long distance conference connection, the customer calls or dials Long Distance and asks for the conference operator. The conference operator records the details of the required connection, including the calling and called telephone numbers and the names of the particular persons desired, and then releases the calling party telling him that he will be called later. When the person calling has disconnected, the operator comes back to his line over a toll switching trunk and holds it without ringing. She then calls each of the desired persons in turn, telling

him he is wanted on a conference connection and will be called again. When all the required persons have been reached and are ready to talk, the operator reaches each again individually, reports that the conference is ready, and connects the calling and called lines with the conference circuit. She then informs the person who originated the call that the conference is "Ready."

If, after attempting to reach all the called telephones on the preliminary call, the conference operator finds that one or more of the desired persons is not available, she holds the other lines, calls the customer originating the conference, reports the situation, and asks for instructions. If he cares to go ahead with the persons available, the operator completes the conference connection. If not, she calls back those whose lines she is holding, tells them that she will call them later, releases all the lines and tries to establish the conference as soon as all the desired persons are available.

Local conference service is still so new that its possibilities for use have hardly begun to be realized. The equipment has been installed in a number of cities, and additional installations will be made as rapidly as sufficient customer demand is developed.

The uses of the service thus far have been interesting and varied. A vice president of a bank periodically calls the managers of nine branches scattered throughout the city to advise them simultaneously of the latest news and quotations received at the main office. The Y. M. H. A. in a large city launched a drive for funds with calls from headquarters to the various neighborhood branches. In this case, 45 branches were reached in a series of five conference connections, each involving the main office and nine branches. The Chairman of the Board of Deacons of a suburban church used to find it next to impossible to get his board together for meetings. Now he calls them all on a telephone conference connection and the necessary business is transacted in a few minutes.

These instances illustrate the great value of local telephone conference service as a saver of time and effort in business transactions and social contacts, where the same message is to be delivered to a number of people at different locations or where agreement among several individuals must be reached. A local conference call may take the place of a series of individual telephone calls or of a group meeting of several busy people coming from different sections of the city. As the public comes to realize its value as a time-saver, this service will undoubtedly attain wide popularity and usefulness.

Long Distance Conference Service

"Happy New Year. A prosperous 1934."

This salutation from St. Petersburg, Florida, was heard simultaneously in Battle Creek, Michigan; London, Ontario; London, England; and Mexico City. Back and forth among these widely scattered cities New Year's greetings were exchanged by a group of business associates on a conference call originated by the head of their company. This novel New Year's party will probably be followed by many others like it, since long distance conference service, even to overseas points, is now generally provided.

Long distance conference connections are made by bridging toll lines together at centers where the necessary equipment has been installed. The equipment required in the case of long distance service is considerably more complex than that for local conferences, since it includes amplifiers and other equipment for offsetting the transmission loss incident to the multiple long distance connections.

Toll conference equipment need not be located at the exchange where the conference call originates nor, in fact, at any of the exchanges where the subscribers involved are located. For instance, for a conference involving Buffalo, Albany, Hartford, and Philadelphia, circuits from each of those points to New York would be bridged together at a New York confer-

ence position, that being the nearest point at which toll conference equipment is at present available.

At present, a six party conference is usually regarded as the maximum for satisfactory two-way long distance communication, although in certain cases as many as ten parties can be handled with satisfactory transmission.

The operating procedure on a long distance conference originating in an exchange having toll conference equipment is similar to that already described for local service. When a conference call originates in an exchange not having toll conference circuits, the conference operator in that exchange records all details of the order and passes them to the conference operator at the nearest center having the toll conference equipment. The latter establishes the conference connection in the manner already described, except that contacts with the calling person are handled by the conference operator in the originating exchange.

Many business concerns with a number of branches are finding periodic toll conferences especially useful in their sales work. For instance, the sales manager of a Chicago company has for over a year been holding conferences with a number of branch offices simultaneously by telephone. This enables him to deliver a personal message to all branches in a minimum of time, and to insure that all branches receive identical instructions. Also, it permits discussions in which all can participate, regional managers reporting on conditions in their areas and offering comments and suggestions regarding the general sales plans. Twenty-two cities in the Middle West have been included in the various conferences called by this sales manager and advantage has been taken of the flexibility of the telephone conference method, the offices to be included and the groupings having been varied as seemed most desirable for each particular conference.

Conference telephone service is being used in both the formulation and administration of N. R. A. codes. During recent

code discussions, the head of a large concern representing his industry in Washington consulted daily by telephone conference with the other leaders of this industry, most of whom were in New York. A county administrator of the N. R. A. building code calls the dealers in his district, as changes in conditions require, to discuss the situation and formulate a consensus on the various questions that arise. Decisions so reached become standard for the area. Since the builders are often away from their offices, the administrator has found it convenient to file his conference calls in advance, so that all the persons called are notified and hold themselves available at the time specified for the conference. The builders in this county have expressed great satisfaction with the telephone conference method, which saves them each at least half a day's time and some traveling expense on every occasion when a personal conference would otherwise be required.

The long distance telephone conference has already taken its place with other types of telephone service as an aid to the medical profession in its battles for human life. A child was dangerously ill in a New Jersey hospital. The physician in charge consulted simultaneously by telephone with a surgeon in New York and a specialist in Cleveland. The three agreed that an immediate operation and the administration of serum were required. On the termination of the telephone conference, the surgeon started from New York bringing the serum, and prepared, with complete knowledge of the case, to perform the operation.

Long distance conference service is, of course, not confined to business transactions and emergency uses. While a marriage by telephone is still more or less of a news item, the holiday seasons, birthdays, and anniversaries are becoming more and more occasions for family gatherings united by means of a telephone conference. For instance, a college student, unable to go home for Christmas vacation, held a telephone reunion from New York with her mother in Colorado, an aunt in

West Virginia, and an uncle in Tennessee. This family had been separated for several years and all of them expressed the feeling that the conference call was their most valued Christmas present.

A New York business man was recently called to Chicago while his wife was visiting in Pittsburgh. It seemed desirable to leave their son at home so that his school work should not be interrupted. Anxiety was avoided by using conference telephone service to keep the family in touch with one another.

A steady growth of these various types of social uses of conference service may well be anticipated as the public becomes increasingly aware of its availability and moderate cost.

Conference Service with Loud-Speakers

The field of conference telephone service is now being further developed by the use of loud-speakers suitable for connection to regular telephone lines, which enable groups of persons to hear local or long distance telephone conversations. Two types of such loud-speakers are now being made available. The smaller unit has a range of volume which may be adjusted to serve as many as 75 to 100 people under favorable conditions. The larger set is suitable for groups of as many as 250 people. These loud-speakers are furnished either for special occasions or for continuous use, the telephone company taking full responsibility for maintenance, including replacement of tubes. The loud-speaker is associated with the subscriber's regular telephone, and may be used whenever he desires to make a local or long distance conversation over his line audible to a group of people. No special equipment is required for sending messages to be received by these loud-speakers, the regular telephone being used. Telephone connections may be made on demand between two telephones equipped with loud-speakers at one or both locations, or on a multi-point conference basis with loud-speakers at one or more points. These connections, however, are not suitable for the transmission of

music, since the transmitters and circuits used for telephone message service are not designed to reproduce as broad a range of frequencies as the microphones and circuits used in high-grade radio broadcasting. Where the customer's requirement is other than that of amplifying an ordinary telephone conversation, special arrangements can, of course, be made for the use of circuits and other equipment of program transmission quality.

The telephone loud-speaker enables an executive to address, personally, groups of employees in distant places, getting his message across with a direct and personal touch and without the possibility of misinterpretation or change of emphasis which might arise if it were passed through organization channels.

Recently, the president of an insurance company made a series of personal talks from his headquarters in Boston to groups gathered in 78 agencies throughout the United States and one in Hawaii. At each agency the talk was amplified by a loud-speaker. The most far-reaching conference of this series included Boston, Mass., Denver, Colo., Portland, Ore., Seattle, Wash., New Orleans, La., San Francisco, Cal., Stockton, Cal., and Honolulu, Hawaii.

At a meeting of executives of another insurance company recently held in New York, it was desired to obtain reports of the results of a sales campaign from team captains located in 27 cities outside of New York and six offices in Manhattan and Brooklyn. This service was arranged by completing 27 sequence appointment calls to team captains at points out of New York in rapid succession and then establishing a conference connection with the six team captains located in the city. A loud-speaker at the main office made the team captains' reports of sales audible to all those present at the meeting. The reports required an average of 32 seconds of conversation time, and the time between conversations averaged about 14 seconds.

Thus the 27 sequence calls were completed and talked on in 21 minutes, which, it is believed, is a new world's record.

No longer need an audience be disappointed when the chief speaker is unexpectedly detained elsewhere. His talk may now come to them by telephone and loud-speaker. The head of a large real estate development company suffered a broken leg two days before the annual convention of his organization. He made the opening address, as scheduled, from his hospital room.

Relatives and friends in distant places need not miss a wedding or other important social function. A wedding ceremony which took place recently in a hotel in New York was picked up by program pick-up equipment and transmitted by means of an ordinary long distance telephone call to the home of the bride's grandparents in Beverly Hills, California, where two loud-speakers had been installed to care for guests in two different rooms. The grandparents and friends, after listening to the ceremony, felicitated the bride and groom over the same circuit and their good wishes were received over a loud-speaker in the New York hotel. This was followed by personal conversations between members of the two parties over regular telephone instruments.

More important than these rather spectacular uses of telephone loud-speakers in emergencies and on special occasions is their recurrent employment as part of the regular business routine.

An advertising executive is finding it convenient to have his copy, layout, and art directors listen around the loud-speaker while a client telephones instructions. They make notes, ask questions and give suggestions which may be passed on to the client. As soon as the conversation is over, each is ready to go ahead with his end of the job and all have a clear understanding of the client's requirements.

A newspaper recently installed a loud-speaker in the office of the managing editor. When a reporter telephones an im-

portant scoop, the editor calls in two or three rewrite men who listen to the story and make notes. The story is divided, each writes an assigned part, and the news is on the press in a fraction of the former time.

The president of a large chemical company spends much time in Washington. A loud-speaker in the office of a vice-president in New York enables the president to hold daily conferences with executives. These daily telephone conferences have been averaging thirty minutes' duration.

These various instances are illustrative of the rapid expansion still taking place in the scope of conference telephone service. The service has so recently been generally offered to the public that its uses thus far give only a faint indication of its ultimate possibilities. As in the case of every new form of telephone service, the Bell System is endeavoring to foresee these possibilities and develop them to the maximum extent. This does not mean only, or even chiefly, providing improved facilities for many-point, country-wide and international conference connections such as some of those described in this paper. It means also the development of the less spectacular phases of the new service to the point where they become an accepted part of the ordinary day-to-day routine of business and social communications and thus attain their fullest value to the community.

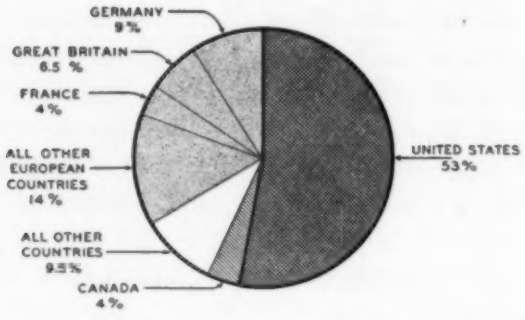
HELENE C. BATEMAN

World's Telephone Statistics

January 1, 1933

ON January 1, 1933, there were 32,941,570 telephones in the world. Of this number, the United States had 17,424,406 instruments, or about 53 per cent of the world's total. Europe had 11,057,215 telephones, or about 34 per cent of the total; while the remaining 4,459,949 telephones, or about 13 per cent, were distributed among the countries of Asia, Africa, Oceania and the Western Hemisphere exclusive of the United States.

DISTRIBUTION OF THE WORLD'S TELEPHONES
January 1.1933

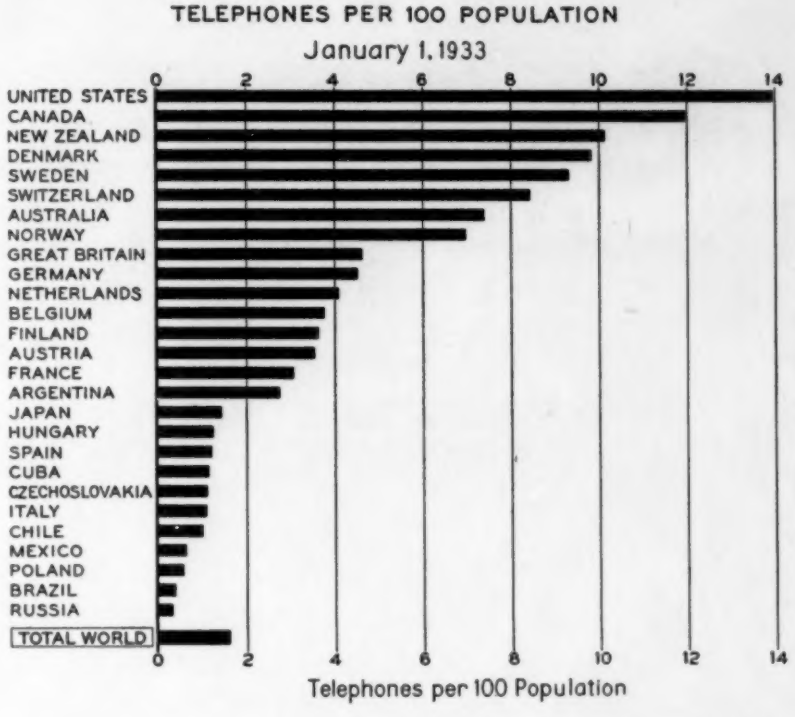


These figures are based upon the latest annual survey of the world's telephone systems made by the Chief Statistician's Division of the American Telephone and Telegraph Company, the results of which have been issued in a pamphlet entitled "Telephone and Telegraph Statistics of the World, January 1, 1933." The tables and charts discussed in the following paragraphs are taken from this bulletin.

Comparative Telephone Development of Countries

The accompanying table, "Telephone Development of the World by Countries," illustrated by the chart, "Telephones per

100 Population," gives the relative standing of the countries of the world in respect of telephone density. As in previous years, the United States, with 13.94 telephones per 100 population, had the highest development. Canada again maintained its relative standing as second on the list, with a development of 11.98. But Denmark, which had previously



ranked third, was passed during 1932 by New Zealand, the latter country reporting 10.12 telephones per 100 population on January 1, 1933, as compared with 9.82 in Denmark. Of the major European countries, Great Britain, with a development of 4.62, was ninth on the list; Germany was tenth, with 4.51; and France was fifteenth, with 3.07 telephones per 100 population. In Asia, the bulk of the telephones are still concentrated in Japan, though its development of 1.44 telephones

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES
January 1, 1933

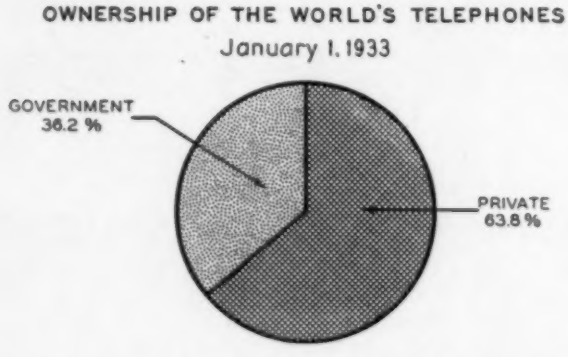
Countries	Number of Telephones			Percent of Total World	Telephones Per 100 Population
	Government Systems	Private Companies	Total		
NORTH AMERICA:					
United States	—	17,424,406	17,424,406§§	52.89%	13.94
Canada	205,711	1,055,534	1,261,245	3.83%	11.98
Central America	11,175	14,167	25,342	.08%	0.39
Mexico	1,427	98,677	100,104	.30%	0.62
West Indies:					
Cuba	485	44,087	44,572	.14%	1.13
Porto Rico	537	11,337	11,874	.04%	0.74
Other W. I. Places	7,101	13,695	20,796	.06%	0.31
Other No. Am. Places	—	11,379	11,379	.03%	3.14
Total	226,436	18,673,282	18,899,718	57.37%	11.01
EUROPE:					
Austria	239,495	—	239,495	.73%	3.55
Belgium**	299,947	9,914	309,861	.94%	3.77
Bulgaria	19,646	—	19,646	.06%	0.32
Czechoslovakia	148,366	19,530	167,896	.51%	1.12
Denmark#	15,803	340,770	356,573	1.08%	9.82
Finland	1,651	133,000	134,651	.41%	3.63
France	1,292,254	—	1,292,254	3.92%	3.07
Germany#	2,960,401	—	2,960,401	8.99%	4.51
Great Britain and No. Ireland	2,146,409	—	2,146,409	6.52%	4.62
Greece	—	17,299	17,299	.05%	0.26
Hungary	110,565	720	111,285	.34%	1.26
Irish Free State#	32,642	—	32,642	.10%	1.11
Italy*	—	467,066	467,066	1.42%	1.10
Jugo-Slavia	46,112	744	46,856	.14%	0.33
Latvia#	58,809	—	58,809	.18%	3.04
Netherlands	332,858	—	332,858	1.01%	4.07
Norway*	119,683	78,000	197,683	.60%	6.96
Poland	95,117	88,850	183,967	.56%	0.57
Portugal	10,445	33,086	43,531	.13%	0.64
Roumania	—	51,191	51,191	.16%	0.28
Russia¶	569,111	—	569,111	1.73%	0.34
Spain	—	280,942	280,942	.85%	1.21
Sweden	575,757	1,524	577,281	1.75%	9.33
Switzerland	346,205	—	346,205	1.05%	8.43
Other Places in Europe	100,720	12,583	113,303	.34%	1.37
Total	9,521,996	1,535,219	11,057,215	33.57%	2.01

SOUTH AMERICA:					
Argentina	—	318,331	318,331	.96%	2.74
Bolivia	—	2,018	2,018	.01%	0.06
Brazil	700	169,693	170,393	.52%	0.39
Chile	—	44,414	44,414	.13%	1.02
Colombia	2,500	28,652	31,152	.09%	0.34
Ecuador	3,000	3,275	6,275	.02%	0.25
Paraguay	—	2,601	2,601	.01%	0.30
Peru	—	15,279	15,279	.05%	0.24
Uruguay	—	29,378	29,378	.09%	1.49
Venezuela	600	22,000	22,600	.07%	0.69
Other So. Am. Places	2,770	—	2,770	.01%	0.52
Total	9,570	635,641	645,211	1.96%	0.73
ASIA:					
British India#	22,109	35,183	57,292	.17%	0.02
China	72,000	75,000	147,000	.45%	0.03
Japan#	965,390	—	965,390	2.93%	1.44
Other Places in Asia	153,708	19,398	173,106	.53%	0.14
Total	1,213,207	129,581	1,342,788	4.08%	0.13
AFRICA:					
Egypt	45,489	—	45,489	.14%	0.22
Union of South Africa#	116,360	—	116,360	.35%	1.40
Other Places in Africa	95,647	1,198	96,845	.29%	0.09
Total	257,496	1,198	258,694	.78%	0.18
OCEANIA:					
Australia*	484,626	—	484,626	1.47%	7.40
Dutch East Indies	39,750	3,657	43,407	.13%	0.07
Hawaii	—	24,206	24,206	.08%	5.90
New Zealand#	151,757	3,803	155,560	.47%	10.12
Philippine Islands	6,000	20,516	26,516	.08%	0.20
Other Places in Oceania	3,401	228	3,629	.01%	0.16
Total	685,534	52,410	737,944	2.24%	0.84
TOTAL WORLD	11,914,239	21,027,331	32,941,570§	100.00%	1.61

* June 30, 1932.
†† February 28, 1933.
# March 31, 1933.
¶ U.S.S.R., including Siberia and Associated Republics.
§ Includes approximately 13,500,000 automatic or "Dial" telephones, of which about 50% are in the United States.
§§ As reported by the United States Department of Commerce, Bureau of the Census.

per 100 population is far below that of the large Occidental countries. Similarly, Argentina, with a development of only 2.74, holds its lead by a wide margin over all the other South American countries in point of telephone density.

The figures indicate that the type of ownership and operation of national telephone systems is probably of considerable significance as regards the extent to which telephone service is developed. Thus, the United States, where the telephone system is all privately owned and operated, has the highest development of all the countries of the world. The next best developed country, Canada, has 84 per cent of all its telephones



under private management; while in Denmark, fourth on the list, about 96 per cent of the telephones are operated by private companies. In striking contrast to the high telephone density of these three countries is the relatively poor telephone development of the three major European nations, Great Britain, Germany, and France, where in each case the service is operated exclusively by the government.

Telephones in Large and Small Communities

It is obvious that no system of communication may be considered to be wholly satisfactory unless it is extensively available, not only to the well populated sections of the country, but also to the more sparsely settled regions. It is, therefore,

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES

January 1, 1933

Country	Service Operated by (See Note)	Number of Telephones		Telephones per 100 Population	
		In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population	In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population
Australia*	G.	276,400	208,226	8.35	6.43
Austria	G.	177,175	62,320	7.57	1.42
Belgium**	G.	207,000	102,861	6.09	2.13
Canada	P. G.	681,000	580,245	21.02	7.96
Czechoslovakia	P. G.	60,547	107,349	3.61	0.81
Denmark	P.	167,563	190,437	17.58	7.13
Finland	P.	50,151	84,500	10.49	2.61
France	G.	739,018	553,236	8.36	1.66
Germany#	G.	1,917,215	1,043,186	7.22	2.67
Great Britain and No. Ireland#	G.	1,561,800	613,800	5.99	3.01
Hungary	G.	84,218	27,067	4.93	0.38
Japan#	G.	615,877	349,513	3.36	0.72
Netherlands	G.	216,855	116,003	6.69	2.35
New Zealand#	G.	58,845	96,715	11.06	9.62
Norway*	P. G.	74,873	122,810	18.53	5.04
Poland	P. G.	111,142	72,825	2.35	0.26
Spain	P.	167,001	113,941	3.54	0.62
Sweden	G.	229,245	348,036	22.45	6.73
Switzerland	G.	155,480	190,725	18.00	5.88
Union of South Africa	G.	63,400	52,200	6.46	0.71
United States	P.	9,842,371	7,582,035	19.52	10.17

Note: P. indicates that the telephone service is wholly or predominantly operated by private companies, G. wholly or predominantly by the Government, and P.G. by both private companies and the Government. See table, "Telephone Development of the World, by Countries."

* June 30, 1932.

** February 28, 1933.

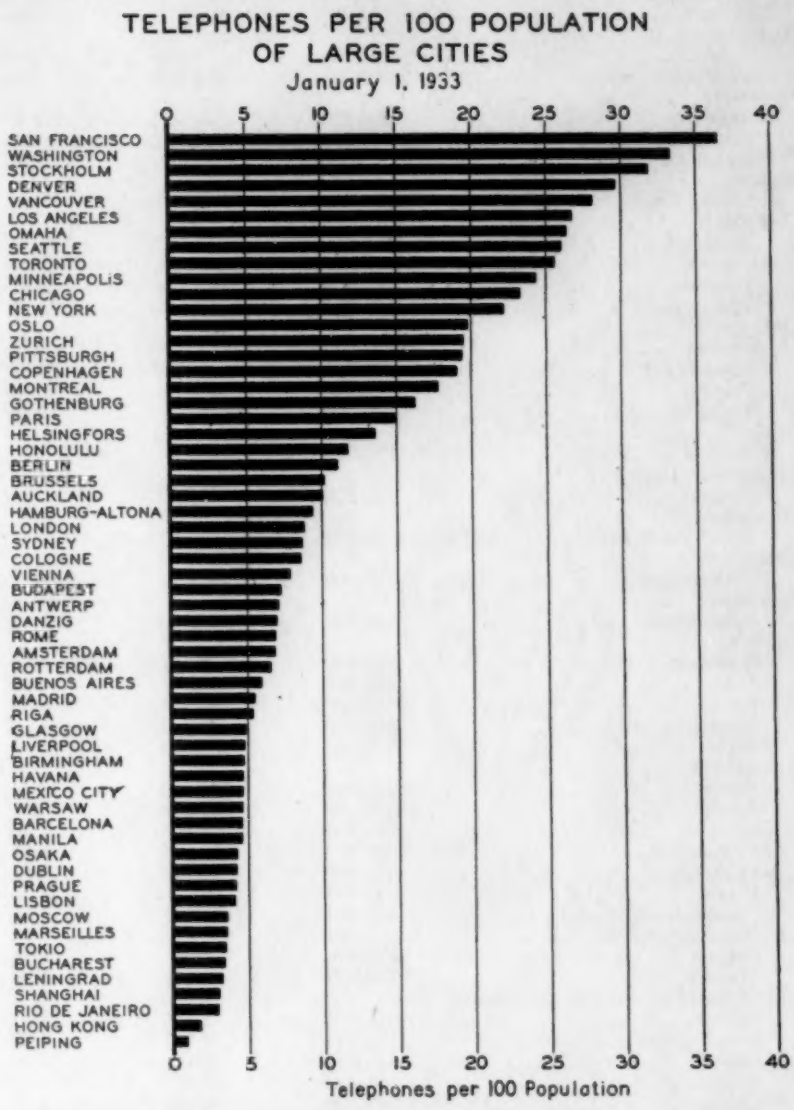
\# March 31, 1933.

interesting to consider the table "Telephone Development of Large and Small Communities" from this particular standpoint. One fact that immediately stands out is that in the United States ample telephone facilities are provided not only in the more densely populated areas, but also in the smaller communities. In fact, the United States figure of 10.17 telephones per 100 inhabitants in communities of less than 50,000 population shows that telephone communication facilities in the American rural districts are more extensively available, relative to population, than are similar facilities in all other countries *as a whole,* with the single exception of Canada. Strikingly in contrast to this high telephone development in the smaller communities of the United States are the corresponding figures for the large European countries. For example, Great Britain has only 3.01 telephones per 100 inhabitants in communities of less than 50,000 population, while similar figures for Germany and France are 2.67 and 1.66, respectively. In other words, so large a proportion of the telephones in these European countries is concentrated in the urban centers that, compared to American standards, service in their small town and rural areas may be said to be practically non-existent. Here again, private initiative seems to have contributed more to social welfare than has government operation.

Telephones in Large Cities

Of the first 12 cities shown on the accompanying chart, "Telephones per 100 Population of Large Cities," nine are in the United States. As in previous years, San Francisco heads the list, with 36.49 telephones per 100 population; and Washington is second, with a telephone density of 33.29. Then follow, in order, Stockholm with 31.83, Denver with 29.67, and Vancouver with 28.09 telephones per 100 population, respectively. Chicago, the eleventh city on the list, had a telephone development of 23.62; New York is next with 22.16. It is interesting to compare the development of New York with that

of the large capital cities of Europe. Thus Paris, nineteenth on the list, had a telephone density of 14.97; Berlin, twenty-



second, had 11.07; while London, twenty-sixth, had a telephone development of only 8.84.

TELEPHONE DEVELOPMENT OF LARGE CITIES
January 1, 1933

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINA:			
Buenos Aires	2,910,000	172,100	5.91
AUSTRALIA:			
Adelaide	326,000	27,656	8.48
Brisbane	334,000	24,715	7.40
Melbourne	1,028,000	92,253	8.97
Sydney	1,262,000	106,472	8.68
AUSTRIA:			
Graz	167,000	8,088	4.84
Vienna	2,000,000	157,432	7.87
BELGIUM:			
Antwerp	530,000	37,363	7.05
Brussels	958,000	97,210	10.15
Liege	427,000	21,605	5.06
BRAZIL:			
Rio de Janeiro	1,700,000	49,850	2.93
CANADA:			
Montreal	990,000	175,672	17.74
Ottawa	185,700	36,501	19.66
Toronto	756,800	193,885	25.62
Vancouver	191,000	53,644	28.09
CHINA:			
Canton	1,000,000	7,300	0.73
Hong Kong	850,000	14,620	1.72
Peiping	1,500,000	12,162	0.81
Shanghai	1,500,000	44,605	2.97
CUBA:			
Havana	750,000	35,208	4.69
CZECHOSLOVAKIA:			
Prague	890,000	37,329	4.19
DANZIG:			
Free City of Danzig	240,000	16,765	6.99
DENMARK:			
Copenhagen	798,000	151,727	19.01
FINLAND:			
Helsingfors	260,000	35,183	13.53
FRANCE:			
Bordeaux	265,000	18,457	6.96
Lille	202,000	16,334	8.09
Lyons	665,000	33,471	5.03
Marseilles	860,000	30,407	3.54
Paris	2,900,000	434,066	14.97
GERMANY:#			
Berlin	4,241,000	469,270	11.07
Breslau	618,000	40,890	6.61
Cologne	743,000	63,898	8.60
Dresden	700,000	58,211	8.31
Dortmund	585,000	23,225	3.97
Essen	649,000	28,426	4.38
Frankfort-on-Main	635,000	61,427	9.68
Hamburg-Altona	1,636,000	153,547	9.39
Leipzig	771,000	64,879	8.42
Munich	736,000	73,569	10.00
GREAT BRITAIN AND NO. IRELAND:#			
Belfast	415,000	17,516	4.22
Birmingham	1,188,000	56,027	4.72
Bristol	414,000	20,196	4.88
Edinburgh	442,000	30,497	6.90
Glasgow	1,185,000	57,833	4.88
Leeds	510,000	23,224	4.55
Liverpool	1,190,000	56,983	4.79
London	9,090,000	798,153	8.84
Manchester	1,097,000	63,712	5.81
Newcastle	470,000	19,229	4.09
Sheffield	516,000	19,287	3.74
HAWAII:			
Honolulu	138,000	16,189	11.73
HUNGARY:			
Budapest	1,021,000	73,928	7.24
Szeged	138,000	1,998	1.45
IRISH FREE STATE:			
Dublin#	419,000	17,601	4.20

TELEPHONE DEVELOPMENT OF LARGE CITIES (Concluded)
January 1, 1933

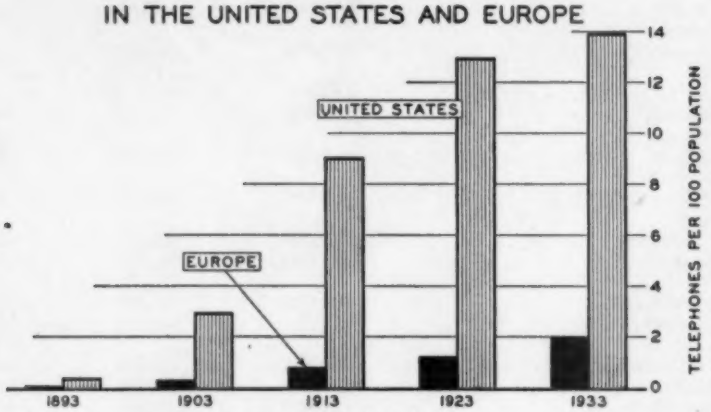
Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ITALY:			
Genoa†	650,000	29,153	4.49
Milan	1,013,000	82,120	8.11
Rome†	945,000	65,173	6.90
JAPAN:#			
Kobe	820,000	30,933	3.77
Kyoto	1,000,000	39,219	3.92
Nagoya	960,000	31,489	3.28
Osaka	2,600,000	110,740	4.26
Tokio	5,300,000	184,034	3.47
LATVIA:			
Riga#	406,000	21,732	5.35
MEXICO:			
Mexico City	1,100,000	51,492	4.68
NETHERLANDS:			
Amsterdam	775,000	53,080	6.85
Haarlem	155,000	11,505	7.42
Rotterdam	615,000	40,310	6.55
The Hague	500,000	47,283	9.45
NEW ZEALAND:			
Aukland#	210,000	21,011	10.01
NORWAY:			
Oslo*	250,000	49,562	19.82
PHILIPPINE ISLANDS:			
Manila	388,000	17,540	4.52
POLAND:			
Lodz	850,000	13,679	1.61
Warsaw	1,200,000	56,100	4.68
PORTUGAL:			
Lisbon	612,000	24,823	4.06
ROUMANIA:			
Bucharest	600,000	20,252	3.38
RUSSIA:			
Leningrad	2,250,000	72,349	3.21
Moscow	3,000,000	106,776	3.56
SPAIN:			
Barcelona	1,000,000	45,200	4.52
Madrid	950,000	52,116	5.49
SWEDEN:			
Gothenburg	251,000	40,746	16.23
Malmö	131,000	20,005	15.27
Stockholm	438,000	139,407	31.83
SWITZERLAND:			
Basel	149,000	28,102	18.86
Berne	113,000	22,019	19.49
Geneva	145,000	25,860	17.83
Zurich	260,000	50,659	19.48
UNITED STATES: (See Note)			
New York	7,114,000	1,576,616	22.16
Chicago	3,521,000	831,679	23.62
Los Angeles	1,357,000	362,597	26.72
Pittsburgh	1,000,100	193,838	19.38
Total 10 cities over 1,000,000 Population	21,894,600	4,618,727	21.10
Milwaukee	745,100	138,772	18.62
San Francisco	672,000	245,196	36.49
Washington	587,800	195,683	33.29
Total 9 cities with 500,000 to 1,000,000 Population	5,980,000	1,236,351	20.67
Minneapolis	498,600	121,456	24.36
Seattle	411,400	107,083	26.03
Denver	295,500	87,682	29.67
Hartford	242,000	52,869	21.85
Omaha	233,800	61,691	26.39
Total 34 cities with 200,000 to 500,000 Population	10,270,500	1,918,542	18.68
Total 53 cities with more than 200,000 Population	38,145,900	7,773,620	20.38

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

† January 1, 1932.
* June 30, 1932.
# March 31, 1933.

The telephone development of a greater number of cities is shown in the accompanying table, "Telephone Development of Large Cities." Of particular interest are the figures relating to the telephone development of the American cities grouped together in various population classes. Thus, the total of 53 cities with more than 200,000 inhabitants, representing a combined population of 38,145,900, had an average development of 20.38. No single large foreign city has a telephone development exceeding this figure, with the exception of Stockholm and the Canadian cities of Vancouver and Toronto.

TELEPHONE DEVELOPMENT
IN THE UNITED STATES AND EUROPE



January 1st of each year

When the number of telephones in each of the foreign capital cities is compared with the total telephones in the corresponding country as a whole, the fact already stated above as regards the relatively high concentration of the telephone service in the urban centers of the foreign countries is brought out still more emphatically. Thus London, with its 798,153 telephones, had about 37 per cent of all the telephones in Great Britain; Paris, with 434,066 telephones, had more than 33 per cent of all the instruments in France; while the four cities of Berlin, Hamburg-Altona, Leipzig and Munich had more than one-fourth of the total telephones in Germany. On the other hand, New

York had only 9 per cent, and Chicago less than 5 per cent, of all the telephones in the United States.

The chart, "Telephone Development in the United States and Europe," indicates the substantial margin by which the United States has maintained its supremacy in telephone facilities over Europe since the year 1893. It shows, furthermore, that even as far back as thirty years ago, the United States was better developed telephonically than Europe is at the present time.

CLEMENT J. KOUKOL

Adventures in Communication

A Lecture Presented under the Auspices of the Massachusetts University Extension Division, as Part of a Series "Adventures in Civilization," Boston, Massachusetts, March 5, 1934.

FROM the dawn of civilization through the days when the Greeks ran over the rugged terrain between Marathon, Sparta and Athens, to this modern era when messages are borne to the far curves of the earth by invisible, intangible, imponderable electric waves, communication has had its full share of adventure.

Many adventures in communication have been adventures in thought and imagination, as well as those where physical risk, or chance, is a factor. In fact, it seems that the word "adventure" has taken on a meaning somewhat different from that given in the dictionary. Risk, chance, hazard, are involved in adventure, according to the dictionary. I shall assume, however, in my remarks today, that adventure also connotes an interesting, stimulating, challenging enterprise. It is an effort toward some accomplishment—an enterprise that stirs man's imagination and challenges his intellect. It is this point of view, which I think prevails in Whitehead's book "Adventures of Ideas," in Fosdick's "Adventurous Religion" and in the three David Grayson books, "Adventures in Contentment," "Adventures in Friendship" and "Adventures in Understanding," that I shall take in presenting to you "Adventures in Communication." They will not involve physical suffering, stamina, or hairbreadth escapes, but they will be adventures nevertheless.

Adventures in Ponderables

The development of communication has been in two contrasting fields of endeavor, in the first of which communication

was dependent upon transportation. In this epoch a message had a discrete existence; it was a ponderable, tangible and visible something. A letter, a document, a sign or symbol on paper, or some physical object was transported. Great adventure centers around the courier, the pony express, the fast mail, the clipper ship, the airplane, the ocean liner, the automobile. Therefore, this aspect of communication has actually involved developments in transportation. In fact, the message was at first, in practically all cases, the one item to be transported.

It was probably in the Orient that trained runners were first employed to carry messages. The courier of the 15th century B.C. hastened with large and heavy letters of unbaked clay, written in cuneiform script. When such messages had been written, an embassy and a heavily armed escort protected the messenger from marauding bands. Strangely enough to us of the 20th century, the embassy carried valuable gifts to insure a welcome for the message.

It is important to point out that messages during these early days had little to do with individuals. Messages were almost entirely between governments, between princes and potentates. Military or naval considerations determined the degree of their importance.

It has ever been an adventure to increase the speed of the message, for it has ever been man's objective to overcome the barriers of time and space. At first both the messenger and the message were placed on horseback. Later, the message alone was dispatched by stage coach, by boat, by train, by airplane. Herodotus, 480 B.C., writes of mounted couriers during the reign of Xerxes as follows:

> It is said that as many days as there are in the whole journey, so many are the men and horses that stand along the road, each man and horse at the interval of a day's journey; and these are stayed neither by snow, nor rain, nor heat, nor darkness from accomplishing their appointed course with all speed. The first rider delivers his charge to the second, the second to the third, and thence it passes on from hand to hand.

On the facade of the New York Post Office appears a well known adaptation of this famous description:

> Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.

An unique method of speeding up message delivery, employed in 1544 in Germany, was the use of stilts to lengthen the stride of letter carriers.

On April 3, 1860, the Pony Express in America began trips between Missouri and California, a distance of 2000 miles. Service was suspended in 1861 on completion of the transcontinental telegraph line. In October, 1783, a stage coach line between Boston and Hartford was established. Later the line was extended to New York. This line had the exclusive government mail contract. A contemporary wrote: "By this unparalleled speed a merchant may go from Boston to New York and return again in 10 days, which is truly wonderful." In 1858 the first overland mail coach reached St. Louis, having covered the round trip from San Francisco in the remarkable time of 24 days and 18 hours. The Government was the principal user and paid several hundred thousand dollars annually for the transportation of letters.

These examples in America of using the speed of animals rather than the speed of men presuppose a mail service. It was in 1691 that mail service was established by a grant from William and Mary. Post riders were dispatched between Portsmouth, New Hampshire and Virginia weekly except during the winter, when trips were made fortnightly. The journey required some 48 days. It was America's first organized system of communication. In 1792 the Congress of the United States enacted the first comprehensive postal law. This step had been strongly urged by Washington in his annual message of 1791. He referred to posts as an instrumentality for spreading the knowledge of the laws and the proceedings of the Government. It is interesting to observe that in his advocacy of the

post, Washington at that time did not envision it particularly as a means of communication between individuals. The social importance of mail service was not generally accepted by contemporary leaders. There was little consideration of it as a factor in the enlargement of men's friendships and horizons. One of the greatest adventures in communication, therefore, is that which resulted in the exchange of letters and relatively small packages between all classes of people throughout the commonwealth.

The next attack on the limitations of time and space came with the harnessing of a new agent, steam. The motive power of legs was discarded. Soon the iron horse, with rapidly revolving wheels supplanting beating hoofs, carried letters and packages with greatly increased speed.

On July 4, 1828, construction of the Baltimore and Ohio Railroad began—the first public railroad in the United States. In 1830 a line 14 miles long was opened between Baltimore and Ellicott Mills. In July, 1831, the iron horse of the DeWitt Clinton train made its first trip between Albany and Schenectady, 17 miles, in an hour and 45 minutes. In June, 1870, the first train across the United States reached San Francisco. I need not tell you of the speed of airplanes as they carry mail across the continent today. In them, still a new agent has been harnessed—the internal combustion engine.

Of all methods of carrying messages, none are more stirring than that of carrier pigeons. The discovery of the homing instinct of certain pigeons, the training of the bird and the development of this instinct to such a high degree, the sheer stamina to fly so swiftly, 80 miles per hour, and for such long distances, upwards of 500 miles,—these are fascinating phases of the enterprise. Pigeons had been used from the earliest times in recorded history. The Bible story of the flood tells of Noah's release of a pigeon. It is recorded that pigeons were dispatched by merchants to their agents inland to announce the arrival of ships. Victors in the Olympic games in 1750

B.C. conveyed by pigeons the tidings of their triumph to the home officials. Today these birds still perform valuable services, particularly in times of war.

I have mentioned the quotation from Herodotus that appears on the New York Post Office. In concluding the discussion of adventures in ponderables, let me read to you some lines on the facade of the recently completed post office at Hartford, Connecticut:

> Across unbounded reaches of the sky,
> Over long trails upon the land,
> By lakes, by rivers and the tractless sea,
> In tempest and in calm, by day and night,
> We speed at your command and bear
> The tidings and the treasures of mankind.
>
> J. BARSS

AN ADVENTURE IN WAVES

Coincident with adventures in communication having to do with the tangible and ponderable were adventures in waves. The major portion of my recounting of adventures in communication will be concerned with adventures in waves—adventures in the realm of the intangible and imponderable. After discussing briefly adventures in sound and light communication, I shall come to what is probably the greatest adventure of all—adventure in electric waves. We shall then be adventuring with a carrier of messages which is intangible, imponderable, invisible and inaudible. The visibility and audibility at the transmitter and receiver are secondary effects produced by electricity, but en route the vehicle, the carrier of the message, sweeps through space or over wires without direct cognizance in any way on the part of human beings. Time and space receive their knockout blow when electric waves are taught "to get the message through."

Adventures in Sound Waves

Perhaps the first of the early great adventures in communication was that of man learning to use sound, not entirely imponderable but highly so. How this came about and how many million years of struggling and experimentation were required before men utilized sound waves to convey information from his brain to another brain is not within my province to discuss. Very likely man soon learned that sound, a vibration in the air which he also breathed, had limitations as a communication system. He could shout, but only over relatively short distances could he be heard. Wind and noise also impaired his ability to shout long distances. It is likely that the phenomenon of echo also taught some perspicacious cave man that sound traveled with finite speed. To the early man, the speed of sound was greater than that of anything else in his environment. Some keen mind might have surmised, from observation and meditation about echoes, that even if one shouted with a voice louder than Stentor's whose cry was as loud as that of fifty other men, facility of conversation would be impaired because finite and appreciable time would be required for sound to carry his words to the listener and to carry words back to his ear. So sound as a two-way medium of communication was not adapted to the basic objective of communication —to break down the barriers of time and space.

However, there have been many instances where sound was used for the practical purpose of signaling in one direction. The thunderclap was an early reality to man. No such loudness of sound as the thunderclap could be produced by man, so he soon appreciated that some sort of relay of sounds would have to be accomplished. Just as a man leaped on a fresh horse, in a sense a relay system, so the sound waves (perhaps one may say they get tired, too; at least they lose their energy en route through absorption and spreading in all directions) can work a relay in a man's brain, prompting him to set off a new sound which will carry on to another observer some dis-

tance beyond. The African aborigine and his tom tom and the beating of stones lying on the ground are notable examples of this system.

In 1825 occurred a most interesting adventure in sound waves and relays. At the opening of the Erie Canal a succession of salutes of cannons stationed between Buffalo and New York was used to announce in New York the starting of the first boat from Buffalo. One hour and 20 minutes was required, the overall speed of the message being 320 miles per hour. Since sound travels 770 miles per hour, 33 minutes would have been the time for sound to travel all the way. In other words, out of the total of 80 minutes, sound itself used 33 minutes, and man's activities required 47 minutes. The relays used up more time than did the sound waves.

Adventures in Light Waves

Sound communication systems would be quite unbearable as a commercial enterprise. Not only does sound travel slowly and relatively short distances, but it is too naïve. It reveals itself too readily to everyone's ears. The air would be full of shrieks, howls and explosions; the fogbound ship would be a haven of quiet even with its fog horns and bells. A swifter and more suitable wave system which was utilized contemporaneously with the transportation of messages by sound was light. Very early in man's history vision itself was a concomitant of speech in communication. A gesture, a nod of the head, a smile, a frown, a grimace—all of these were parts of face-to-face conversation and very soon might have been recognized as communication in themselves. No more thrilling chapter in the consideration of adventures in communication could be found than in the recital of the use of light waves. Reflection of the sun's rays by mirrors, the use of smoke, fires, flags, semiphores, lanterns, lighthouses—these and many variations of them have had and still have a part to play in communication. Greater speed and a longer range of signal-

ing was the answer of light waves in breaking the barriers of time and space. Light's own speed as a wave phenomenon was so far above that of sound waves that the only limit to speed of signaling was the speed of operation of the signaling mechanism. As was the case in the Erie Canal episode, where more time by about 140 per cent was consumed in relay operation than in transmission of sound, so with light, practically all the time of signaling was consumed by the mechanism. The light rays have a speed of 186,000 miles per second, sufficient to travel 7 times around the equator in a second. When a vehicle of such speed was utilized for man's purposes, that was an adventure.

In the play "Agamemnon" by Aeschylus, signal fires carried the news of the fall of Troy to Argos in 1084 B.C. Beacon fires were placed on Mount Ida, Athos, Citheraon and on intervening eminences. Beside them sentinels were placed to watch for the signal and in turn set fire to their own. When the city fell, a nearby fire was kindled and beacon after beacon sprang into flame on the route towards Greece.

The ancient Britons used beacon fires to warn the country of the approach of an enemy. Beacons were so frequently used in early English history that certain hills were actually called Beacon Hills. I believe that the hill on which we are this very moment is sometimes referred to as Beacon Hill, Boston. From its height a beacon fire may have blazed up on many occasions. I do recall something about hanging a lantern in the Old North Church, one if by land and two if by sea.

The news of the sighting of the Invincible Armada in 1588 was sent all over Great Britain by a long chain of beacons stretching from Cornwall to Cheviot Hills, the boundary line between England and Scotland. Macaulay tells of the remnants of these beacons "still to be seen on the capes of the seacoast and on many inland hills."

On the night of June 21, 1887, a re-enactment of beacon fire communication was a part of the Queen Victoria Jubilee Cele-

bration. "Hill answered to hill, until at last all the uplands of Great Britain were alight from the tiny summits of Scilly. The signals went north to Midlothian shores tinged with ruddy glow." An English friend of mine recalls with great interest this re-enactment of an adventure in communication as one of many great spectacles in the Victorian Age.

In the realm of visual signaling, an interesting adventure was the semiphore system of J. R. Parker of Boston. Semiphores are mechanical arms which are like a traffic officer's arms signaling STOP and GO. In 1833, Parker personally managed a 12-mile line of semaphores extending northward from Boston along the coast. The line was in operation 7 years, was operated by 5 persons employed from sunrise to sunset, and messages were conveyed the 12 miles in 2 minutes —which was real speed in those days! From a point along the shore signals were sent to the wharf, and it is recorded that 7000 arrivals of vessels were signaled for the benefit of the commercial interests of Boston business men.

I have searched with some care for more information relating to these earlier sound and visual adventures. Aside from the Erie Canal episode, in which sound took 80 minutes to go 428 miles instead of 33 minutes, and the Parker semaphores in which light required 2 minutes to go 12 miles instead of 1/15,000th of a second, I have found but few references to speed and only inferences as to distance. It would be interesting to know how long it took for a light signal to travel from Troy to Argos in 1084 B.C. and compare the average speed with that from Scilly Isle in Wales to Edinburgh by beacon fires as was done in 1888 during the Queen Victoria Jubilee.

Adventures in Electric Waves

Contrary to popular opinion, electricity is not in its infancy. High school graduation essays notwithstanding, the surface of electrical utilization has been more than scratched. Twenty-four centuries ago Thales of Miletus, of Greece, is supposed to

have recorded observations about electrical phenomena. Ever since that day electricity has been the subject of continuous experimentation, but always the discoveries pertained to isolated facts which admitted of no correlation or useful application. Finally this violent phenomenon of nature as exhibited in lightning flashes, the catastrophic effects of which are equalled only by earthquakes and floods, was tamed and harnessed and understood. Electricity is generally regarded as a 20th century or perhaps a 19th century subject. Our conceit is, however, jarred by realizing that in 1733, Dufay, a French scientist, wrote a history of electricity. In 1767 Joseph Priestley who, I believe, was the discoverer of oxygen, published another history of electricity. But apropos of our adventure of discussing adventures in communication, what did electricity offer as a vehicle, a carrier, a transporter of messages?

In 1730 Stephen Gray, an English student of natural science, did an interesting and adventurous experiment. He charged a metal body with frictional electricity. One charges one's own body by scuffing one's feet over thick carpets and gets a slight shock when the hand touches a metal door knob. The charged metal sphere of Gray's, however, was connected by a wire to a down feather at a distance of 1000 feet. The feather would move at the far end of the wire when the near end was touched to the sphere. During these experiments the distinction between conductors and insulators was recognized. The day of this experiment is really a most significant one in the annals of adventures in communication.

In 1745 William Watson sent a charge of electricity to a point 6 miles away where the arrival of the electric charge gave a spark and ignited some hydrogen and oxygen in an enclosed vessel. This was a forerunner of the automobile spark plug. In 1776, an important date in the history of Boston and Philadelphia, Alexandro Volta, an Italian scientist, sent an electric charge from Como 30 miles across the Lombardian Plains to

Milan, where similarly to Watson's experiment, inflammable gases were exploded. That electrical impulses could be transmitted from one point to another through a conductor, whether that conductor was a metal wire or the human body, was adventurously (and here one may say "adventurously" as per the conventional definition), was adventurously demonstrated during these same years when Abbé Nollet sent a shock along a hand-to-hand circle of 180 Royal Guards. On another occasion, over 2500 monks in a line one mile long were electrically shocked.

However, as years went by, electricity was of little practical use. Exploding gases in glass jars, human beings cringing from electric shock, and flitting feathers—none of these offered much promise as receivers to function quickly and surely in a communication system. It was recognized that electrical impulses traveled with incredible speed, practically the speed of light, but sheer speed was not the only talent necessary; the legs of men and beasts, the wings of birds, the noises of sound and the flashes of light were much more tractable and reliable message bearers.

The Adventure of Magnetism

During the years of the 18th century, electricity was electricity, electrical phenomena were solely electrical—one might say the dual personality of electricity had not yet been discovered. The "I" of electricity was known but the "me" was unknown. One must travel to Copenhagen in 1819 to learn of the "me" of an electrical phenomenon. In that year Oersted was engaged in a most significant adventure. He discovered that an electrical phenomenon does not have a discrete and separate existence *per se*, but rather is one phase of a dual phenomenon; he discovered that an electrical disturbance and a magnetic disturbance always accompany each other. Oersted discovered that if you start with what appears to be solely an electrical effect there will be an associated mag-

netic effect. Conversely Faraday, a truly great electrical adventurer, in 1831 discovered that if you start with what appears to be solely a magnetic phenomenon, an electrical phenomenon will be inextricably bound with it. Figuratively speaking, the dual personality of electricity was revealed.

The phenomenon of magnetic attraction is a bit more tractable and docile than electric attraction. One can handle small horseshoe magnets; nails and tacks can be picked up and compasses moved without the human organism being aware of any shocks or pain. When, therefore, it was discovered that the arrival of the electric current from a distant point could be detected magnetically rather than electrically, a great era in communication had dawned. At the receiving end a compass needle might be moved. By wrapping the wire, carrying the electric current from the distant point, about a small bar of iron, the bar would grip to itself a second small bar of iron placed near it. When the electric current stops, the first bar of iron releases its grip on the second. The magnetic grip is firm and positive, but is serene and shocks no one. The motion of the compass needle or the motion of the iron bar responding to the magnetic grip and release could readily be made to convey information.

The Adventure of Telegraphy

The credit and honor of making a great discovery or applying a great discovery to man's needs seldom belongs to a single individual. Oersted, Ampere, Sturgeon, Wheatstone, Weber, our own Joseph Henry and S. B. F. Morse—all had an important rôle in the adventure of telegraphy. Morse, an artist, had observed during a trip to Europe the fundamental workings of electric currents, compasses and electromagnets and saw that with the perfection of a code—dots and dashes on a piece of paper, or long and short clicks of sound—electricity (and magnetism, too, one must really say) could be made to carry messages. After centuries of research, this most whimsi-

cal, this most intangible, most imponderable, most untractable, most unknowable something, but withal the swiftest something in man's environment—this agent Electricity with its shadow, Magnetism, was the David that was to slay the Goliaths, Time and Space.

On January 24, 1838, Morse sent a message by electricity and magnetism over a 10-mile wire circuit. In 1844 a telegraph line between Washington and Baltimore was opened with the historic phrase "What hath God wrought." In 1846 New York and Boston were connected by telegraph lines. In 1861 telegraphic communication between the Atlantic and the Pacific was received by East and West with great enthusiasm.

The development of telegraph service brings to our attention a great adventure—an adventure teeming with hazard, chance and suffering. This adventure might be called the magnificent failure. To connect America to Europe by telegraph was the challenging task. Cyrus Field said it could be done by a cable laid on the bottom of the sea. A cable laid in 1858 had failed. Undismayed though Field was, the public and the engineers were skeptical of his ultimate success. It seemed certain that a telegraphic link to Europe must run westward by land rather than eastward by sea. There was a day when a route to India was thought to be westward by sea rather than eastward by land. To stretch a thread of copper 16,000 miles long from Boston westward to the Pacific Northwest, thence to Alaska, thence by a short section of cable under the Bering Strait to Siberia, across the wild wastes of Russia to Moscow and on to Berlin, Paris, and London, required courageous imagination and herculean labors. Morse said the project was feasible; Congress supported it. William H. Seward, Secretary of State, enthusiastically gave his endorsement. To survey and build 16,000 miles of telegraph line, a good share of which was through unmapped wilderness, was an adventure. Work began in the winter of 1865; in spite of tremendous difficulties and suffering, many miles in the 1800

miles' stretch from Ashcroft, British Columbia, to Bering Strait via Sitka were blazed. The Russians actually started construction on a portion of the line from Moscow eastward toward the Pacific.

Meanwhile Field continued his submarine cable adventures. Few men expected that a telegraph cable could be laid without mishap on the ocean floor. In July 1866, the steamship *Great Eastern* hove in sight at Trinity Bay, Newfoundland. The cable she had been reeling out all the way from England was pulled ashore and telegraphic service by cable between America and Europe marked the completion of another great adventure. The success of one great adventure spelled defeat for another. At once the intercontinental telegraph route became but a memory; vestiges of it are still to be seen in Western Canada; millions of dollars had been lost and many lives sacrificed.

High spirit and good sportmanship were a bright spot in this magnificent failure. Secretary Seward wrote "I would not have the Atlantic cable dumb again, even if thereby I could immediately secure the success of the inter-continental telegraph enterprise."

James Russell Lowell put electricity and its swiftness, the transatlantic submarine telegraph cable, and time and space in a poem—Agassiz:

> The flame winged feet
> Of Trade's new Mercury, that dry shod run
> Through the briny abyss dreamless of the sun,
> Are mercilessly fleet
> And at a bound annihilate
> Ocean's prerogative of short reprieve.

Adventures in Telephony

Amid the great public interest in the success of the transatlantic submarine telegraph cable Emerson had written "electricity must teach his nimbleness to earn his wage, spelling

with guided tongue man's messages." So it was; man's message had to be spelled in code. Trained operators at transmitter and receiver had to translate and re-translate the message. Could this agent electricity, that had finally become of very practical value, be made to transmit, not only clicks or dots and dashes, but also words and sentences—speech? Could its nimbleness be taught to voice with facile tongue man's languages?

I am not unmindful of the privilege to speak here in Boston on "Adventures in Communication." It is most appropriate to do so in the birthplace of the telephone. Alexander Graham Bell, working here in Boston and in Salem, discovered that electricity could voice man's languages, that speech could be translated into electric current, could be transmitted by this electric current and, at the receiver, retranslated into the sounds of the original words.

I recall hearing Professor Pupin of Columbia University recite an incident in connection with Bell's success. Pupin, a youth from Serbia, was having great difficulty with the English language. To learn to speak and understand English was of paramount interest and importance to him. In 1876, during the years he was struggling with the language, he went to Philadelphia, and there saw the telephone demonstrated under Bell's own direction. Out of the receiver, emerging from the circular iron disc, came words—English words, Chinese words, Greek words, French words, Serbian words (whichever were spoken into the transmitter). Young Pupin decided that America was no place for him—America, where an iron diaphragm had been taught to speak any language, and he could not learn to speak English. It was best to return to Serbia. He did not return, however.

In 1878 Bell said "The telephone actually speaks and therefore can be used for nearly every purpose for which speech is employed." Of all the agencies employed in communication, the telephone was and is now the most wonderful.

The word itself, "telephone," is meaningful; its etymology is "far sound." Therefore, as soon as it was an accomplished fact that electrical counterparts of man's ear and mouth did exist—the telephone transmitter may be regarded as an electrical ear into which you speak and the receiver as an electrical mouth which speaks into your ear—and that they, together with wires between, could function in "far sound," the next adventure was to speak to more and more people within one community and to farther and farther communities.

Adventures in Wires, Cables, and Switching

A single telephone is of no value. There must be at least two telephones. To be of larger and larger usefulness to an individual, there must be many other telephones to which one may be connected quickly and separately. Two telephones need one pair of wires interconnecting, three telephones need three pairs of wires interconnecting, four telephones need six pairs of wires interconnecting $(4 \times 3)/(2)$, five telephones need ten $(5 \times 4)/(2)$, six telephones need 15 $(6 \times 5)/(2)$, ten telephones need 45. The arithmetic is easy: the number multiplied by the number less one divided by two. One hundred telephones give combinations totalling practically 5000.

Telephone conversation is a private, dual affair. A telephone subscriber, disregarding for the present party lines, must therefore have an individual line from his telephone to either a central office that is a switching center or to every other telephone. It is inconceivable that every telephone have a wire actually running directly to every other telephone. In that event, in each home there would need to be a 50-foot square switchboard with tier upon tier of terminals with a track ladder like that in a shoe store in front, by which connections could be made. Such a scheme is of course fantastic and absurd. It would also be most inefficient; some of the circuits would be used but a little while each day; some of them would never be used. In New York and its environs there were a few years

ago 1,400,000 telephones. The required number of pairs of wires without central offices would be one million million. This is roughly one and one-half million times as many as actually used with central offices. Hence switchboards or central offices became an adventure.

With 10,000 subscribers with private lines, there of course must be 10,000 wires running to the central office where the switching is accomplished. Among these 10,000 subscribers there may be 50,000,000 possible connections. In the first telephone switchboard of 1878 at New Haven, Connecticut, there were eight lines; $8 \times 7 \div 2 = 28$ possible switchings. Actually there were about 10 telephones in rural fashion, on each line, so that 80 subscribers were served. In 1882 a complete multiple switchboard with a capacity of 200 subscribers was designed; then came boards with 2400 subscribers; today we have 10,500-subscriber switchboards. By means of individual wires and switchboards in large cities, Boston having 50 central offices, there may be possible interconnections requiring a number with which only astronomers can compete.

Wires, sheer wires—how many there are running from homes and business houses to central offices. To place them, to connect them, this has been an adventure. At one time these telephone wires seemed to be strung everywhere. Myriads of them were visible to the passerby, on housetops, and from building to building along the street. They required tall poles with many crossarms.

These wires and poles were vulnerable to storms and accident. Each wire must be kept from touching any other wire. Could they be put in smaller space? The cable, that is, a lead pipe with wires inside, each wire insulated from its neighbor by a thin sheath of paper about 1¾ thousandths of an inch thick, was the answer. In 1912, 900 pairs of wire, each .025 inch in diameter, could be placed within a lead pipe, outside diameter 2⅝ inches. In 1914, 1200 pairs of wires, each wire .020 inch diameter, could be squeezed in the same size lead pipe. In

1928, 1800 pairs of wires, each .016 inch diameter, were squeezed in the same size lead pipe. All this sounds prosaic—mere wires on poles placed along the street, mere wires in pipes under the ground, but to accomplish it was not prosaic—it was an adventure.

Each day, 72,000,000 telephone connections are made and unmade between persons wishing to talk with each other. The switching may be done by the telephone operator or it may be done by machines. The establishment of connection by automatic machinery has been a great adventure. Among so many permutations and combinations, the operation of the dial by the subscriber directs electrical arms and hands, one may say, to select the pair of wires running to the desired party. Signaling, that is, the ringing of your telephone bell and the signaling between operators before there can be conversation, is in itself no mean adventure.

In the United States there are about 20,000 telephone central offices connecting about 16,600,000 telephones; 87,000,000 miles of wire are involved. Wherever a person may be, some pair of wires in the great network of wires and switchboards of orderly and systematic arrangement, will be selected by a tandem operation of human arms and hands or electrical arms and hands from a gigantic number of possibilities, to reach that person. The magnitude, complexity, orderliness of it all, is shattering.

With adventures go thrills. When one stands at the corner of Summer and Chauncy Streets here in Boston, one cannot see the 40 telephone cables that lie beneath the pavement. In these 40 cables there are 37,180 pairs of wires. They are subscribers' wires, a pair running from each subscriber to the central office. At this busy surface traffic corner there is much greater telephone traffic. Electricity quietly, serenely, unobtrusively, effectively, and speedily carries 5000 conversations every 2.1 minutes during the busiest periods of the day. If either messenger boys, or sound waves or light waves, were

the message bearers, traffic congestion, terrible din of noise or blinding, fluttering lights would make this corner unbearable to vehicle and pedestrian traffic.

Adventures in Miles

Telephone—"far sound"! Could electricity carry the voice really afar? The first telephone circuit here in Boston was perhaps 50 feet long. Then came a two-mile circuit between Boston and Cambridge. Then 10 miles; then more miles. It was soon learned that like the legs of men and horses, like the wings of carrier pigeons, even like the iron horse and gas engine, which must be fed now and then with coal and gasoline, the electric waves carrying the voice got tired, figuratively speaking. Just as sound waves and light waves die out after traveling long distances, so did electric waves die out or thin out—attenuate, the engineer says. Large wires, wires as big as a lead pencil, were used to diminish the attenuation, to help the electric waves go farther. But 1000 miles seemed about the limit of distance to which electric waves by the power given them at the start could carry a voice on a pair of wires. The reason they could go no farther was that their power, their vitality, was used up in the circuit along the way. If their power, their vitality, could be dissipated less rapidly, then obviously they could go farther. How to diminish, how to decrease the rate of losing their power, became a great adventure.

Further Adventures in Magnetism

You will recall that I said a while ago that no electric circuit can be thought of as being purely electric. Every electric circuit has a magnetic side to its personality. Through the work of Lagrange, a Frenchman, of Heaviside, an Englishman, Professor Pupin of Columbia University, and Dr. Campbell of the American Telephone and Telegraph Company, it was found out how, purposely and in proper amounts, and at regular

intervals, to add magnetism to the circuit so that it became a more efficient medium for electric currents. By placing magnetic coils ("loading" coils they are often called) along the circuit, it was possible to reduce the rate of dissipation of power which the electric waves encountered in traveling along wires. Hence the waves could go farther on their original starting power. For distances even less than 1000 miles, and particularly along wires in cables, these "loading" coils are of great value, and of course with them the "far" aspect of speaking was greatly extended—to 1800 miles or so. These doughnut shaped coils, with iron rings forming the core, and wires wrapped around, like the one I hold in my hand, are placed in large metal boxes to protect them from the weather. You may observe them along the highway where telephone cables parallel the road.

In its theoretical phase, the "loading" coil problem was distinctly a mathematical adventure. This problem afforded abundant confirmation of Bacon's assertion "For many parts of nature can neither be invented with sufficient subtility nor demonstrated with sufficient perspicuity nor accommodated into use with sufficient dexterity without the aid and intervening of mathematics."

Adventures in a Vacuum

Even with "loading" coils to assist the electric current to go farther, and to minimize attenuation, there nevertheless was too much attenuation if the distance was very great, and to span the continent with a telephone circuit was not possible without further adventures. Could more power be put into the original current at its starting point? Could weaker currents be utilized at the receiving point? Could some energy be supplied en route? Could the waning waves be rejuvenated along the way? Could some sort of relay, operating instantly, be placed in the circuit—a fresh horse, as it were, for the pony express, or new powder for explosions along the Erie Canal?

This latter problem was attacked. A slow, bulky relay could not follow all the minute modulations of the human voice being carried electrically. The electric voice must be sent along with renewed power, undistorted, untwisted. A new kind of relay capable of practically instantaneous action without inertia must be sought.

Electricity itself was the answer to the problem. In the years from 1895–1912, much had been studied and learned about electrons and electron streams. Electrons are very tiny atoms of electricity; electron streams are like bullets from a machine gun, millions of them streaming from their source—in one case the incandescent wire within an electric light bulb. These streams, unlike a stream of water or bullets, were practically without inertia; that is, they could be made to speed up or slow down, unlike an automobile, which opposes being made to go faster or being made to go slower after it is going fast.

Three different telephone repeaters, all of them electronic, and one mechanical device of earlier origin, were developed by Bell scientists and engineers. They were given official tests in the early winter of 1914. The telephone repeaters equipped with the 3-electrode vacuum tube gave the best performance. Edison, Fleming, DeForest and Richardson had made important contributions to this 3-electrode vacuum tube. A number of such electrode-tube repeaters were installed on the telephone line connecting New York and San Francisco. In 1915, this 3000-mile circuit was opened and the last barrier of time and space in the United States was smashed. The challenge of time and space had in reality been met by understanding not only how electricity traveled and coursed its swift flight along wires, but also how electricity acted inside of a glass bulb from which the air had been pumped out. There is no magic about a vacuum tube or an amplifier tube. To be sure, it serves and does its part so quietly, so serenely, so effectively and with such great agility that it has been called the modern Aladdin's lamp. However, scientific developments are not matters of magic;

they are matters of understanding. I say again, an understanding of how electricity performed in vacuum and how it was conducted through various gases was responsible for this repeater. And, as one may facetiously observe, there was a lot to understand about nothing.

Today there are about 350,000 amplifier or repeater vacuum tubes in the telephone circuits of the Bell System. On a New York-San Francisco call, 200 repeater tubes perform their very important rôle of adding new power to the electric currents. The power itself is supplied from batteries connected to the repeater.

It takes at most .1 of a second for the voice to make the journey of 3000 miles. Unlike the human-cannon sound-repeaters along the Erie Canal, which used 47 minutes, the time consumed by the 100 vacuum tube relays in tandem is a very small fraction of the .1 second total time.

Adventures in Frequencies

Realizing the rôle that the telephone plays in all countries of the world, one readily assents that electricity has been a fine student of linguistics, speaking with facile tongue the languages of mankind. In so doing, the undulations, that is the risings and fallings, of the electric current follow with faithful fidelity the intonations, inflections, the naturalness, and the articulation of speech. Generally speaking, the vowels of speech are low in pitch; the frequency, that is the swings back and forth each second of time, may be 200, 300, 400, 500, perhaps 1000. The consonants which give the articulate elements in speech require the higher frequencies: 2000, 3000, 6000, 10,000. Now it was discovered that electricity, or rather electric vibrations, were capable of a most astounding range or gamut of frequencies. Electrical frequencies from one vibration per second to 100,000,000 per second can be produced, measured and controlled. The existence of these frequencies cannot be detected directly by the senses of man, that is hearing, feeling

or seeing. They can be put to work by man, they can be divided into groups, and each group can carry a message. In other words, it became possible to send more than one message along a wire simultaneously with several other messages. Each message, either telephone or telegraph, has its particular electrical color band, one may say. Even though all the color bands are coursing along the wire at the same time, they do not interfere with one another. When a group of persons are looking at a Corot landscape painting, the various colors of the painting do not get mixed up as they are conveyed by light waves to the separate eyes of the many in the group. Human eyes act as detectors of the several colors. Electrical detectors pick out the several groups of electrical frequencies.

The adventure in frequencies therefore made it possible to transmit four telephone conversations and four telegraph messages over a single pair of wires. The frequencies and the messages have also been distributed to achieve one telephone message and 20 telegraph messages.

Adventures Without Wires

Beethoven was born in Bonn on the Rhine. There he composed his symphonies and played his concertos. Little did he dream that some day his symphonies and concertos were to be heard not only by those actually present in the concert hall but also by thousands and even millions in their homes many miles away. Little did he dream that in his native country the scepter of art was to be passed to a science from which radio was destined to be developed. Almost coincident with his death was the birth in Hamburg of Heinrich Hertz. Later, Hertz lived and worked in Bonn for several years. As music was enriched by the genius of Beethoven, so science and communication were generously endowed by the researches of Hertz. It was Hertz who in 1886 at Karlsruhe for the first time in history experimentally proved the existence of radio waves. By physical apparatus he produced radio waves (really elec-

tromagnetic waves) and at a short distance detected them, and of course this was tacit proof that they had been transmitted through space without wires. As I have previously said, electrical phenomena do not exist alone; there are always accompanying magnetic phenomena. Likewise, it is really a misstatement to say that an electric current passes through a wire. From a fundamental and basic point of view the intangible and imponderable electrical and magnetic phenomena in the space around the wires equal, and perhaps exceed, in importance the phenomena within the wire. In other words, the wire is rather to be thought of as a guide, a directive channel for the electric and magnetic disturbances. It was Hertz who made the great discovery that these effects could be transmitted through space without wires. Radio communication stirs the imagination, captures the interest and baffles the understanding of the layman. On many occasions one hears the statement, "Well, I can understand how wires can carry the voice and music but I just can't imagine how they all can come so clearly and loudly right into my home without anything to carry them." Really, however, there is nothing more mysterious, more non-understandable about radio than about an electric motor. The armature or rotor is being twisted about by an invisible force, electromagnetic in character, whose invisible fingers and hands reach through space and clutch the rotor so that it is twisted around and around. The principles of radio are as well understood as the principles of motors and electric lights.

Through his great contributions of the antenna and ground, —that is, holding aloft one wire of the radio transmitter and connecting to ground another wire, Marconi gave greater scope to the electro-magnetic waves of Hertz. The great adventure of Marconi of sending a radio signal across the North Atlantic from Cornwall to Newfoundland marked a new day in long distance communication. If because of this contribution and other great contributions, Marconi is called the father of radio,

one must remind oneself that a child is endowed with heritage not only by his parents but also by many ancestors. Also one must remember that a child has many uncles, aunts and cousins: Volta and Righi, other Italians, and Lodge, Braun, Thomson, Hughes, Henry, and Lord Kelvin, are but a few of the older members of the family—the grandfathers and great uncles as it were. More recent members of the family remind one of the old lady who lived in a shoe.

The vacuum tube amplifier that plays such an important rôle in long distance telephony by wire, was also a highly important factor in long distance radio telegraphy and telephony. It was realized that if these amplifiers could be made to handle voice power measured in horse power, then the tiny voice power as it emerges from the mouth and is translated into electric power by the microphone—then this tiny voice power could be made larger and larger and larger at a radio transmitter until it could be projected into space from the antenna with many horsepower of power. So vacuum amplifier tubes of large physical size and large power capacity, compared to tubes in a telephone line or in your radio receiver, are keystone elements in both long distance radio telephony and broadcasting. Adventures with a vacuum, with glass, with electron streams within the vacuum, with metals, have created from nature's storehouse something which nature itself did not produce. Nature lets loose a lightning flash and a blast of thunder. Man's intelligence applied to natural phenomena provides a high power vacuum tube which, without flashing light or roaring thunder, hurls man's voice electrically into space to the antipodes where human ears and human eyes could not have heard or seen the sound or light.

As in wire communication, so in radio communication, telegraphy first spelled man's messages. Later, radio telephony with seven-league boots advanced by leaps and bounds and then radio broadcasting swept into civilization like a hurricane. A number of gold ingots of fact and principle in electricity and

acoustics assayed during many preceding years from tons and tons of ore in the crucible of fundamental science were taken by commercially minded men from the treasure chest, the keys of which had been kept unwittingly by science itself, and seemingly in a flash radio broadcasting occupied the stage. But radio broadcasting was not invented in 1920. Several centuries were required to develop it. Without special engineering, radio waves spread out in all directions, and hence are inherently well adapted to one-way communication. Broadcasting captured the imagination of millions—to hear speech and music from many distant points was a thrilling adventure. Directed beams of radio waves are also inherently well adapted as communication links between countries separated by wide expanses of sea or desert and also for communication between shore and ships at sea. From New York are radio telephone links to Europe and South America. From San Francisco radio links reach out across the Pacific to Hawaii, to Java and the Philippines. From London and Berlin and Paris and Holland and Java and Australia, radio systems catapult the spoken word between the far curves of the earth.

Wire telephone systems so well adapted for conversation with one and only one listener within the network of land connections, supplemented by radio links between networks, have made 92 per cent of the 33,000,000 telephones of the world into a single web with many, many threads and wide horizons.

From Boston to Sydney, Australia, is a voice journey 14,000 miles long. In 1/13th of a second, the "Hello" from Boston is carred by electric waves to Sydney. Sound waves would require 18 hours. In 1/13th of a second, sound travels about 80 feet. So one may say by the swift flight of electric waves 14,000 miles of space is squeezed into 80 feet. It is like talking with a man 80 feet away. Time and space so annihilated bring about interesting contrasts. When chilly blasts blow around Boston Common, bathers are diving into the surf at Sydney. Men bundled in fur coats, between deep drafts of

hot coffee talk with those sipping iced tea. Whatever day it is in Boston, it will be tomorrow in Australia. If at four o'clock in the afternoon you call a friend in Adelaide, he may express displeasure at being wakened just before dawn and may ask "Why are you calling me yesterday?"

From a mundane point of view, radio waves are space-spanning and time-annihilating. We hear much about the man and the message from Mars. If we did communicate with the man in Mars by radio, I fear the conversation would be somewhat stilted, even if we talked his language. For the radio waves to reach Mars, 3 minutes would be required, and 3 minutes for his answer to come back. This is the minimum time. At another time of year when the planets are in a different configuration, 20 minutes going and 20 minutes returning would be the time. Quite a bashful conversation.

Adventures in Television

Telephone conversation is a very good substitute for face-to-face conversation. Smiles, frowns, and gestures must be imagined from an interpretation of the character of the sound. Could this swift and versatile agent, electricity, carry images, moving images, could one see by electrical waves—that would be another great adventure in communication. If the job is to be done, one must seek electric counterparts of man's talents. As the microphone or transmitter may be regarded as an electrical ear into which you speak and the receiver as an electrical mouth which speaks into your ear in a telephone system, so one must find an electric eye with which to see, to substitute for the human eye in a television system. Also at the remote point, the receiving end, an electric hand equipped with an electric paint brush or electric crayon, as it were, must be made to draw a picture in perhaps 1/16th of a second; that picture must be erased and another picture drawn in the next 1/16th of a second, and so on, and so on for all the time you are seeing your friend or a putt by Francis Ouimet. Such electric

eyes and electric hands and brushes have been dug from nature's storehouse of electrical and physical phenomena. Electric waves of great agility and capability to vibrate most quickly and also most slowly, and all the way between most quickly and most slowly, are required. The concept of television, the adventure of seeing at long distance through the medium of electro-optical systems and electric waves, is not of recent origin. Carey in 1875, Ayrton and Perry in 1877, Nipkow in 1884 and Rignoux and Fournier in 1906, made specific experiments in television per se. Davy, Faraday, Hertz, Hallwachs, Elster, Geitel, Geissler, Plucker, Hittorf, were adventurers in the scientific fundamentals. By 1923 several experimenters had succeeded in televising shadows. The presentation of an image of the living form was accomplished in 1926 and 1927. At first, the sending of images was from one room to an adjoining room. Later the distance was extended to miles, 200 miles in fact. Real television, the presentation of an image of a living form, is 8 years old. The first images were very crude. Notable improvement has been made, but the images which have as yet been transmitted are not good enough to warrant acceptance by the public in a commercial sense. Television is complicated, costly, and offers many seemingly baffling problems. Baffling problems—therein lies adventure.

Adventures in Business Enterprise

I have presented to and interpreted for you a number of adventures in the instrumentalities and methods of communication. There are many others of great interest and importance. To break down the barriers of time and space is an achievement, but it is not enough. Communication service, telephone service, must be just that—service. Service which is more and more free from imperfections, errors and delays. To reduce the time necessary to establish a connection seemingly is a prosaic adventure. Instead of waiting 30 minutes,

10 minutes, 5 minutes, one is now told to hold the line while the connection is set up from Boston to St. Louis, to New York, to Washington, to New Orleans, to Seattle. Once trouble had to be taken out of your telephone, your line, your bell box once a month, then only once every 6 months, now only once in a year or two. These appear prosaic tasks but actually are highly important.

The telephone business in the United States was not vouchsafed by guardian angels or Delphian Oracle to be a substantial and successful business enterprise. The telephone business was no sinecure. In spite of many obstacles, some almost fatal, it survived. A policy and purpose—may I say an ideal?—to render the most and best service at the least cost was the objective. Scientists and engineers practically assure technical progress, but without adventurous business management which seeks to conduct the enterprise so that it may be a profitable business, the telephone would not have made the notable progress that it has made. "Profitable" does not mean speculatively and excessively profitable. "Profitable" means profitable to the telephone subscriber, to the public welfare, to the employee, and to the stockholder. Profitable to all parties means the best possible telephone service at the lowest cost consistent with financial safety. To conduct business thus is truly an adventure, comparable to wires, waves, electrons, and frequencies. It is a long run adventure but nevertheless an adventure.

In this adventure of management and conduct of telephone service as a business enterprise, there is one factor which does involve, to a pronounced degree, risk, chance and apprehension —a factor where a miss is as bad as a mile. This factor is public reaction, public opinion. When new developments bring changes in communication facilities and service, the big question is not whether the technical and operating features of the venture will work satisfactorily. These have been tested and tried in the laboratory and in the field. The big

question is whether the new facilities and methods will be accepted in good spirit or in critical spirit by the public. Will these facilities and methods be suited to the needs and the likes of the public? Will the public believe you? It may listen to your aims and objectives and even your ideals, but will it believe you? That is the gamble.

An ancient philosopher said that continued recourse to experimentation is but a device of feeble minds, an attempt to discover, in a rude manner, what we should know by calculation and logic. I doubt whether many of the great adventures in communication would have been achieved solely by calculation and logic. What new and worthwhile successes to be achieved by calculation and logic or experimentation or both, are ahead, no one knows. We do know we shall keep on calculating and experimenting and shall try to do both with imagination, but what is ahead no one knows. That is the adventure.

J. O. PERRINE